RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 54 MARCH, 1950 No. 3

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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Vol. 54 MARCH 1950 No. 3

The Mechanism of Skull Fracture[1]

E. S. GURDJIAN, M.D., J. E. WEBSTER, M.D., and H. R. LISSNER, M.S.

Detroit, Mich.

Deformation patterns of the skull due to blows of low velocity, as well as the mechanism of production of linear skull fracture, have been previously described (1–5). When the dry skull is coated inside and out with "stresscoat" brittle lacquer, and then subjected to a blow, the lacquer cracks in the areas of greatest tensile deformation. The cracks appear on the outside of the skull in the regions in which the bone bends outward and on the internal surface where the bone bends inward. A region of inbending—generally circular, oval, or star-shaped—always surrounds the point of application of a blow, no matter where it is struck. Where the skull curves sharply, however, the extent of the inbending is not so great as in a less curved region. By means of the "stresscoat" technic, it has been shown that outbending of bone may occur at a considerable distance from the point of application of the blow. In some specimens a *contrecoup* type of outbending has been observed approximately diagonally opposite the point of impact.

A study of the "stresscoat" pattern of deformations of the skull and comparison with clinical fractures indicate that most linear fractures are initiated on the outer surface of the skull by tearing-apart forces due to outbending of the bone. The evidence shows that a linear fracture due to a blunt blow insufficient to cause a depression is formed as follows: At impact, the area around the point of application of the blow is inbended. Simultaneously there is an outbending of the bone peripheral to the inbended area. This outbending is selective and may be localized to a certain part of the skull, where a linear fracture is initiated due to the resultant tearing-apart forces. The fracture then extends toward the point of impact and in the opposite direction. Extension is directly toward the region of impact rather than to one or the other side, because, although initially this area is in compression (bent in), it rebounds immediately after the energy of the blow has been absorbed and becomes an area of tensile stress. A fracture which has started at a considerable distance will, of course, propagate in a direction normal to the greatest tensile stress. Therefore it must travel toward the center of the area of impact. If insufficient energy was expended in the blow, the fracture may remain limited and not reach the point of impact.

The present study deals with the determination of areas of primary, secondary, and tertiary stress levels in the skull as a result of blows in various locations and

[1] From the Department of Surgery and Engineering Mechanics, Wayne University, and Department of Neurosurgery, Grace Hospital, Detroit, Mich. Aided by the Grace Hospital Research Fund. Accepted for publication in February 1949.

the correlation of these findings with an analysis of experimental and clinical skull fractures.

In the study of threshold deformations, it was found that, as the energy of the blow was increased, the "stresscoat"-covered skulls presented more extensive patterns of cracks in the lacquer as a result of more severe deformations. The appearance of the first cracks following an impact at a given point denotes the area of primary stress level. When more energy is used to produce additional cracks in the lacquer, the resultant patterns indicate the area of secondary stress level. When still more energy is used, the cracks surround the region of impact in a radial manner, the additional areas of deformation constituting the regions of tertiary stress level. This information provides data regarding the position and order of the occurrence of fractures following blows of sufficient energy to produce fractures. The results obtained were verified by the production of experimental fractures in intact cadaver heads. The positions of clinically observed fractures were also compared with the results of the "stresscoat" tests.

METHOD AND MATERIAL

The skull surface was divided into the following areas: (1) midfrontal; (2) anterior interparietal; (3) posterior interparietal; (4) midoccipital; (5) frontal, lateral to the midline; (6) anterior parietal; (7) posterior parietal; (8) parietooccipital (Fig. 1). It is, of course, evident that the midline areas are single and the lateral areas are bilateral, making a total of twelve areas over the upper portion of the skull. These areas are roughly rectangular, measuring 2 × 3 in. Blows were administered in these regions, the point of impact being within the confines of the rectangles. Only the left side areas and the midline positions will be described.

While this division of the surface of the skull is arbitrary, and each area is fairly large, it was thought to be more desirable than to make smaller subdivisions. Not only would it be difficult to identify a smaller area when locating the position of the blow on the intact scalp, but differences in the shape of the skull in various specimens were found to be of such a degree that the selection of smaller areas was impractical (48 areas had been previously outlined and studied). Variations in the deformation pattern obtained are a function of both the exact location of the blow and the structural and shape characteristics of the particular skull tested. There is, however, enough similarity in the stress patterns with blows in a given area to justify the conclusion that the general deformation patterns following a blow within the confines of that region are consistent.

"Stresscoat" tests of the skulls were made in a manner that has been previously described in detail (1, 2). After coating the skull with a brittle lacquer and permitting it to dry, the specimen was dropped onto a heavy steel slab to obtain tension cracks in the lacquer in the region of the greatest tensile stress in the bone. The location and direction of the cracks in the lacquer indicate the location and direction of fracture in the bone if the blow is struck with sufficient energy.

Areas of primary, secondary, and tertiary stress levels of the skull due to a blow in one of the twelve specified areas were determined in the following manner. When the minimum amount of energy required to produce the first few cracks in the lacquer was applied to the skull, the cracking occurred in the area of the primary stress level. With the application of a blow of greater energy in the same region of impact, the lacquer cracked also in areas of secondary stress level. With the application of a blow of still greater energy, cracks were found in the lacquer in areas of tertiary stress level in addition to the cracks in the two areas previously described. These areas of stress level are of significance in that, if a single linear fracture is produced by a blow, it will be initiated in the region of the primary stress level. If a blow of greater energy is applied, a second fracture line will probably occur in the area of secondary stress level;

with still more energy, fractures will occur in areas of tertiary stress level.

The experimental skull fracture tests were made on embalmed cadaver heads with scalp and contents intact, for comparison with the data from the "stresscoat" studies regarding the location and direction of fracture lines due to blows in specific regions, and to evaluate the influence of the presence of scalp and skull contents. These tests were also used to determine the energy requirements for fracture of the intact head. The cadaver head, supported by means of a cord looped about it in such a manner that it would strike in the desired area when dropped, was allowed to fall freely through a measured distance and strike a 160-pound steel slab placed directly on a terrazzo floor. The product of the weight of the head and the distance through which it was dropped determined the energy of the blow. It was usually possible to predict a fracture from the characteristic sharp sound accompanying the failure of the bone. The delineation of the fracture was made by removal of the scalp and pericranium. The skull was then completely cleansed and the brain removed to obtain the weight of the dry skull. Photographs of the fracture were made for record purposes. The thickness of the scalp was measured in each instance. Great variation was noted in this respect.

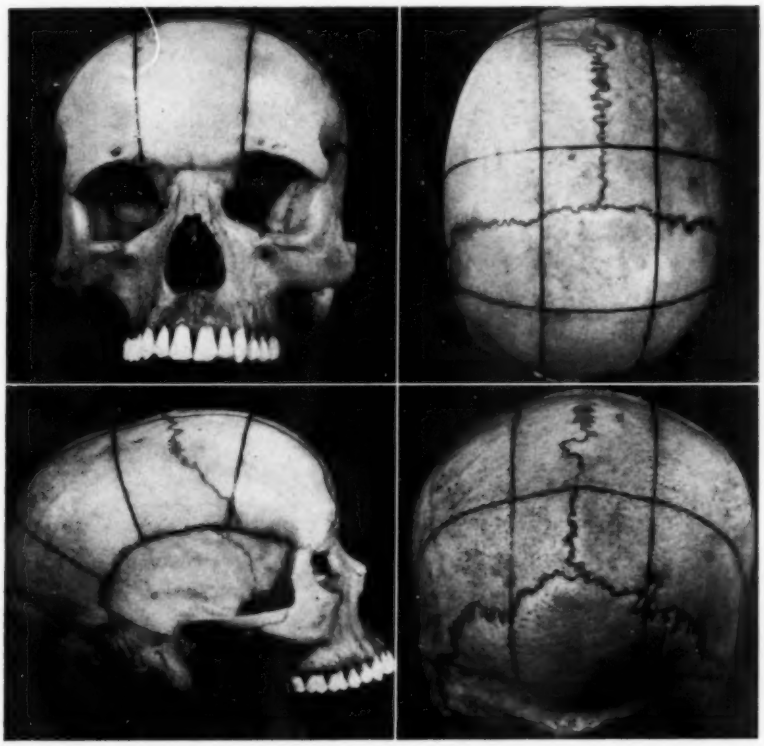

Fig. 1. Division of the calvarium into twelve areas, rectangular in shape and measuring approximately 2 × 3 inches. The midline areas are midfrontal, anterior interparietal, posterior interparietal, and midoccipital. The lateral areas are frontal lateral to the midline, anterior parietal, posterior parietal, and parieto-occipital. The temporal regions on either side are well buttressed with muscle tissue and are seldom injured by blunt blows.

Roentgenograms of clinical fractures were also studied and comparisons with the "stresscoat" records were made. A piece of

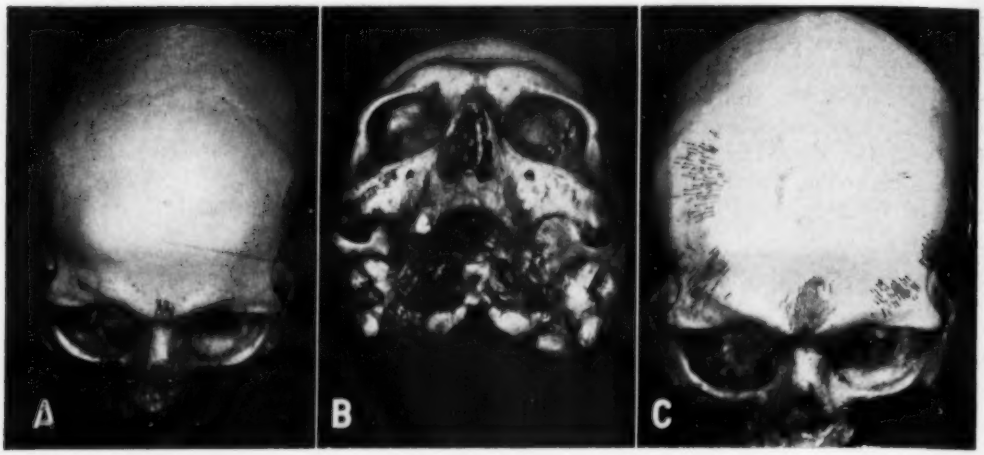

Fig. 2. Results with midfrontal blows of varying energies, showing areas of primary, secondary, and tertiary stress levels. In this particular specimen, the area of primary stress level is at the frontonasal junction at the midline (A). The areas of secondary stress level are in the supraorbital notch region on both sides (B), and the areas of tertiary stress level are in the frontoparietal regions, bilaterally, and the intermediate areas between the midfrontal and lateral frontal regions (C).

radiopaque material was placed at the region of impact so that the position of the fracture line in relation to this area could be determined.

EXPERIMENTAL AND CLINICAL FINDINGS

Areas of Primary, Secondary and Tertiary Stress Levels Due to Blows in Twelve Regions of the Surface of the Skull, Determined by "Stresscoat"

Midfrontal Blow: A blow in the midfrontal region resulted in deformation patterns either in the midline frontonasal junction or immediately over the orbits in the region of the supraorbital notch on one or the other side. These are the areas of primary stress level. When the energy was increased, cracks appeared in the lacquer in both of these positions. That is, if the initial cracks were in the midline frontal region, there now appeared cracks in the supraorbital rim margin bilaterally. At the same time there were cracks in the lacquer in the roof of the orbit, indicating tearing-apart forces from side to side, with an inclination medially. Evidence of tearing-apart forces also occurred at the frontozygomatic and lateral frontal regions. When still more energy was used, cracks appeared in the lacquer in the lateral frontal and the parietofrontal regions on both sides (areas of tertiary stress level), in addition to those mentioned above (Fig. 2).

On the basis of these observations, it may be postulated that a fracture line would be initiated in the area of primary stress level when an impact of sufficient severity occurred. When more energy is used than required to cause a single linear fracture, the second line of fracture may appear in the area of the secondary stress level. When still more energy is applied, a stellate type of fracture may obtain, with fracture lines extending from the nasion, the supraorbital notch, the lateral frontal, and the parietotemporal regions, toward the point of impact. Verification of these experimental "stresscoat" findings may be seen in Figure 10.

Anterior Interparietal Area: Threshold studies with an anterior interparietal blow resulted in deformation patterns in the right or the left parietotemporal region (area of primary stress level). When more energy was involved, cracks appeared in the lacquer in both parietotemporal regions. When still more energy was utilized, tearing-apart forces caused radial cracks surrounding the area of impact anteriorly,

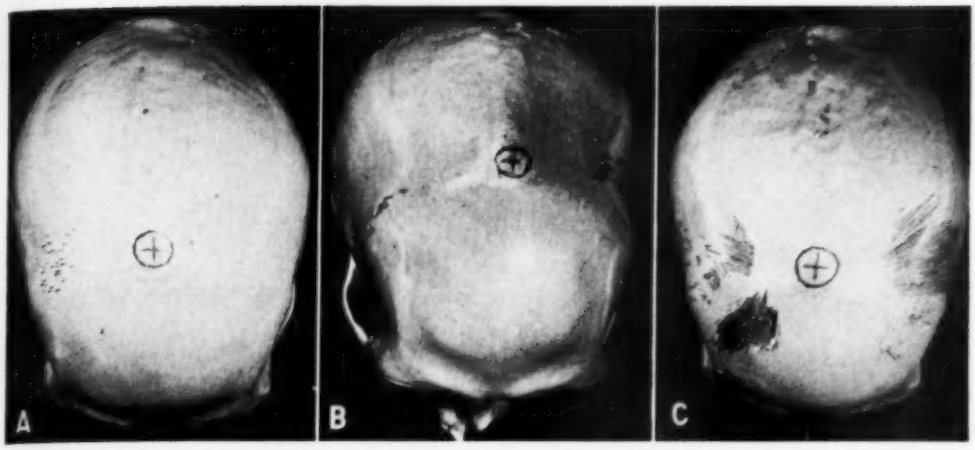

Fig. 3. Studies with anterior interparietal blows of varying energies, showing the areas of primary, secondary, and tertiary stress. The region of primary stress level is in the right parietal bone (A) the area of secondary stress level is in the left parietal bone (B) and the region of tertiary stress level is in the frontal bone on either side of the midline and in the interparietal regions posteriorly (C).

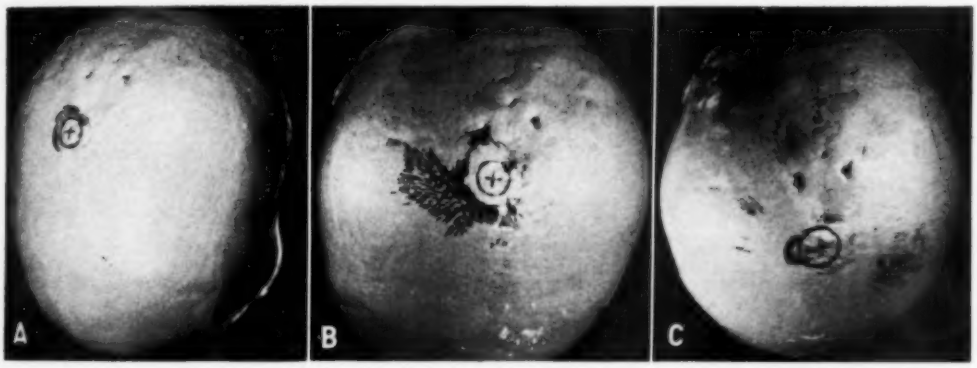

Fig. 4. Results with posterior interparietal blows with increasing energies, showing areas of primary, secondary, and tertiary stress levels. The region of primary stress level is immediately about the point of impact (A). Areas of secondary stress level are noted posteriorly and in the left parietal region (B). More extensive patterns of deformation are noted with tearing-apart forces in the right parietal, the anterior interparietal, the left parietal, and intermediate zones, representing areas of tertiary stress levels (C). In this particular skull the pattern with a smaller amount of energy, as shown in B, differs from that with a greater amount, as shown in C. This may be a function of the position and direction of the blow.

laterally, and posteriorly, as well as in the intermediate zones.

In the specimen shown in Figure 3, with adequate energy the first fracture line should occur in the temporoparietal region on the right side. If more energy were used, bilateral temporoparietal fractures would result (Fig. 18). If still more energy were available, a stellate type of fracture would occur, with fracture lines extending up toward the point of impact from all directions.

Posterior Interparietal Area: In Figure 4 the results of a posterior interparietal blow are shown. The threshold deformation pattern comprises only circular cracks around the point of impact. When the energy is increased, there are evidences of tearing-apart forces lateral to the point of impact on the right side. The direction of stress is anteroposteriorly lateral to the point of impact and from side to side anterior to the blow. When still more energy is applied, there are tearing-apart forces

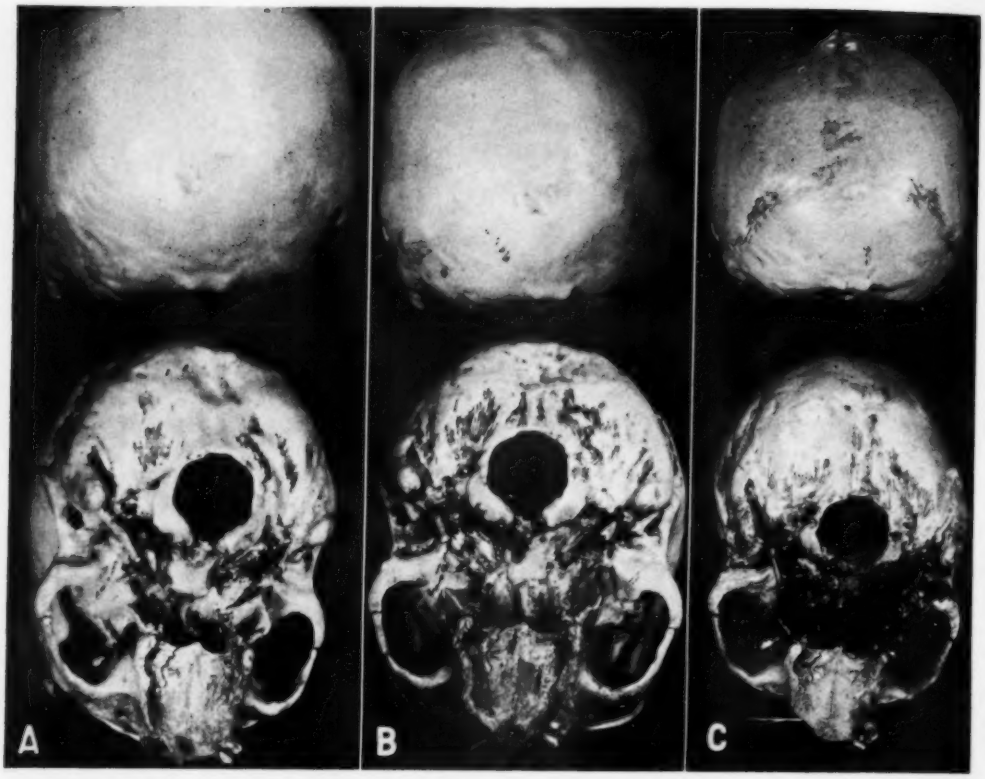

Fig. 5. Results of midoccipital blows with varying energies, showing the areas of primary, secondary, and tertiary stress levels. To the left (A) the patterns of deformation are essentially at the base of the skull on either side of the foramen magnum (area of primary stress level). In the middle views (B) there are beginning cracks in the lacquer in the parieto-occipital region on the left (area of secondary stress level), and to the right (C)there are cracks in the lacquer in the parieto-occipital region on both sides as well as at the base. The area of primary stress level is at the base of the skull about the foramen magnum. The area of secondary stress level is in the left parieto-occipital region, and the areas of tertiary stress level are in the right parieto-occipital regions as well as in the intermediate zones about the point of impact.

predicting fracture lines in a stellate formation.

As a result of the presence of bony structural irregularities and a slight change in the position of the blow, one may see a variation in the stress pattern as shown in Figure 4. Thus, due to a slight variation in the position of the blow, a more extensive deformation may be obtained with a blow of lesser energy.

Midoccipital Area: Figure 5 illustrates the results of gradually increased energy absorption due to blows in the midoccipital region. With the smallest amount of energy there are tearing-apart forces from side to side at the base of the skull and on either side of the foramen magnum. With more energy, there are tearing-apart forces in the left parieto-occipital region as well, and, with still more energy, in both parieto-occipital regions in addition.

With energy adequate to produce a single linear fracture, that fracture should be at the base, extending from the region of the foramen magnum to the point of impact. With more energy, a second line of fracture may occur in the left parieto-occipital region, extending horizontally toward the point of impact. With still more energy, there may appear, in addition to those fractures already described, one or two lines of fracture in both parietal regions, extending horizontally toward the point of impact (Figs. 12, 13, and 14).

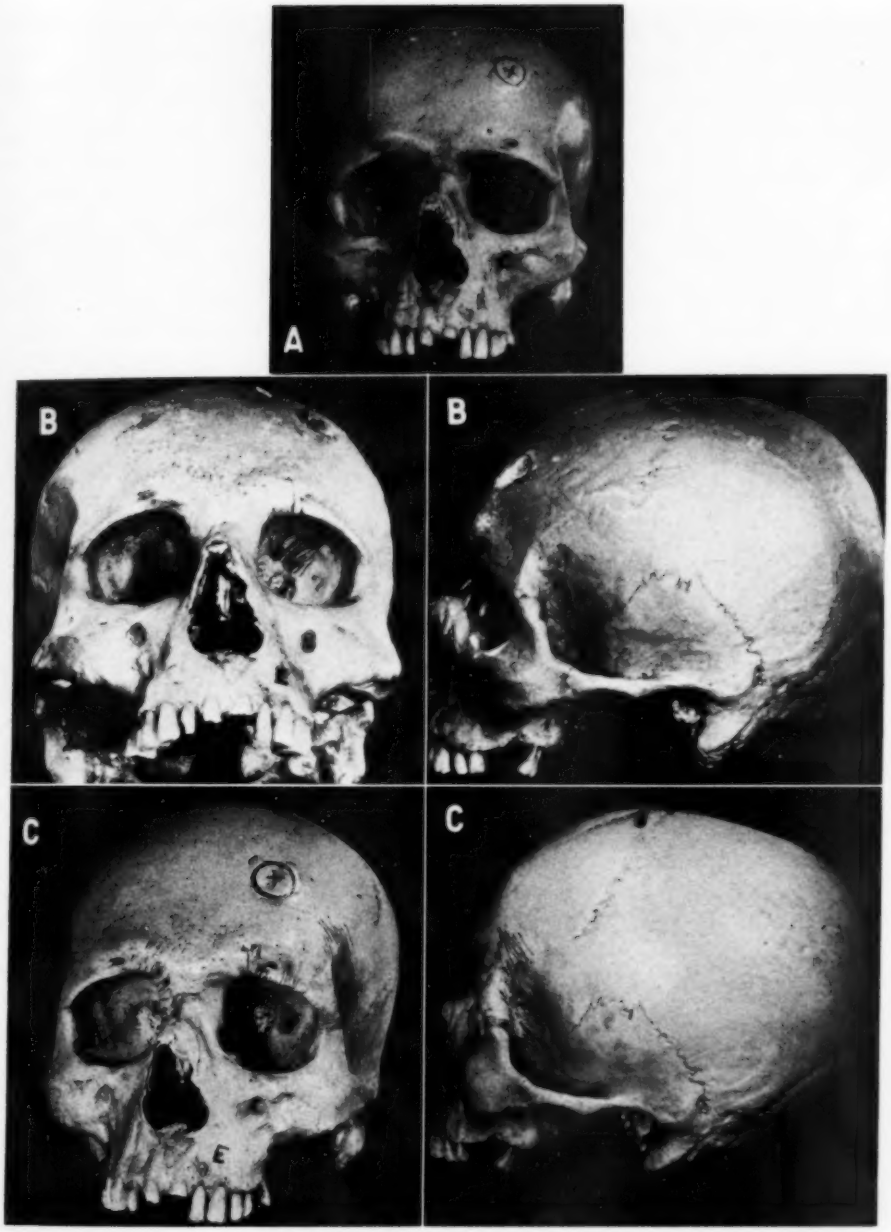

Fig. 6. Results of frontal blows to the left of the midline with varying energies, showing the areas of primary, secondary, and tertiary stress levels. In A, only a few cracks in the lacquer are seen at the supraorbital notch on the left side. In B, cracks are seen at the roof of the orbit as well as in the lateral frontal region of the frontozygomaticotemporal area. The photographs in the lower row, C, show cracks in the lacquer in the left and right supraorbital regions and the lateral frontal region bilaterally. The area of primary stress level is in the region of the supraorbital notch on the left side. The area of secondary stress level is in the lateral frontal region on the left side, and tertiary stress level characteristics are noted in both supraorbital regions and both lateral frontal regions as well as the zygomatic arch on the left side.

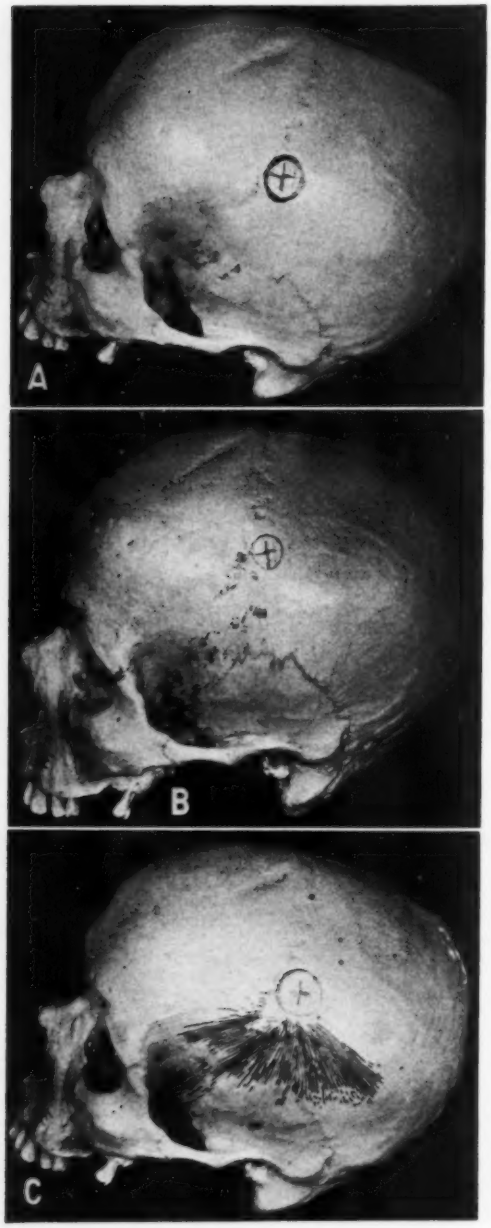

Fig. 7. Results with left anterior parietal blows with varying energies, showing areas of primary, secondary, and tertiary stress levels. In A, the area of primary stress level may be seen in the temporal region. In B, there are a few perpendicular cracks in the lacquer extending upward toward the area of impact as well as slanting cracks in the temporal region extending upward and backward toward the area of impact. The perpendicular cracks represent a new line of force with secondary stress level characteristics. In C, there are now cracks in the lacquer extending upward and backward toward the point of impact, straight upward toward the point of impact, and upward and forward toward the point of impact, the latter group representing the area of tertiary stress level.

Frontal Area, Lateral to the Midline: In Figure 6 a frontal blow to the left side of the midline is seen to result in a few cracks in the lacquer at the left supraorbital notch. With additional energy, the stress extends to the roof of the orbit and to the lateral aspect of the frontal bone at its junction with the zygomatic bone. When still more energy is used, there are many cracks in the lacquer over the frontal bone on either side of the midline. There is evidence of stress bilaterally along the lateral frontal and zygomaticosphenoid junction. A blow on the frontal bone lateral to the midline may thus result in a single fracture extending from the supraorbital notch to the point of impact. If more energy is absorbed, a second line of fracture may occur in the lateral frontal region, either extending toward the point of impact or toward the orbital rim. As a result of still more energy, a stellate pattern will result, involving the frontal bone on either side of the midline.

Anterior Parietal Area: Figure 7 shows the result of an anterior parietal blow on the left side. Varying energies have been used. The weakest region following an impact of this type is in the temporoparietal area (area of primary stress level), with tearing-apart forces causing cracks in the lacquer extending upward and backward toward the point of impact (Fig. 19). With more energy, there are added tearing-apart forces anteroposteriorly, and cracks in the lacquer extend upward from the mastoid region (region of secondary stress level). Still more energy results in at least three main groups of cracks, all extending to the point of impact: (1) upward and backward; (2) vertically; (3) upward and forward.

Posterior Parietal Area: The results of posterior parietal blows on the left side with varying energies are shown in Figure 8. Following a minimal blow, cracks are found in the lacquer extending from the

Fig. 8. Results with posterior parietal blows with varying energies, showing areas of primary, secondary, and tertiary stress levels. In A, tearing-apart forces resulting in cracks in the lacquer in the temporal region represent the area of primary stress level. In B, there are in addition to the cracks in the lacquer in the temporal region, also cracks medial to the area of impact, representing a region of secondary stress level; whereas, in the photographs in the lower row (C) we now have evidence of tearing-apart forces posterior to the area of impact, in addition to those superior and medial to the area of impact and in the temporoparietal region. The additional group of cracks represents the areas of tertiary stress level.

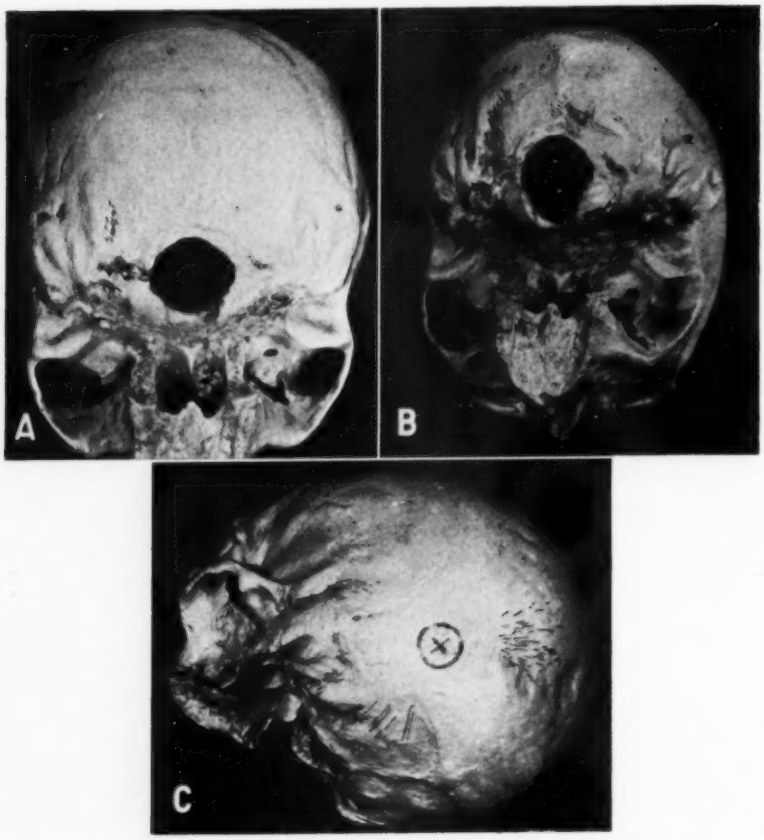

Fig. 9. Results with parieto-occipital blows with varying energies, showing the primary, secondary, and tertiary stress levels. In A, the area of primary stress level is noted in the base of the skull to the left of the foramen magnum. In B, secondary stress level characteristics are noted posterior to the foramen magnum, with cracks in the lacquer slanting across the midline. Areas of tertiary stress level are noted in C, with cracks in the lacquer in the parietomastoid region and in the parieto-occipital area medial and superior to the area of impact.

temporofrontal junction up toward the point of impact. With a more severe blow, the cracks are more extensive in the temporal region. There are also cracks in the lacquer superior to the area of impact. With added energy, there are at least three distinct areas of deformation producing cracks: temporoparietal, superior parietal, and mastoidoparietal.

As a result of a blow in this neighborhood with adequate energy to produce a single fracture line, the fracture may be expected to extend from the frontotemporal junction upward and backward toward the point of impact. With more energy, there is a possibility of an additional fracture in the superior parietal region, crossing the midline and also extending toward the point of impact. If still more energy is involved, there may be a stellate pattern, with fracture lines extending vertically upward toward the point of impact from the mastoid region, in addition to the other fractures mentioned above (Fig. 15).

Lateral Parieto-Occipital Area: In Figure 9 are shown the results of blows in the lateral parieto-occipital region. With the smallest amount of energy, the initial cracks in the lacquer appear at the base of

the skull, to the left of the foramen magnum (area of primary stress level). With more energy, there are also evidences of tearing-apart forces on the right side of the foramen magnum (area of secondary stress level). With still more energy, cracks appear in the mastoidozygomatic region as well as in the occipitoparietal area above and medial to the point of impact, in addition to the patterns previously obtained in the base.

A blow in this area may cause a fracture line extending from the region lateral to the foramen magnum to the point of impact (Fig. 23). Additional energies result first in a slanting fracture, extending from the other side of the foramen magnum, across the midline, toward the point of impact. Finally, there may also be fractures in the superior occipitoparietal and zygomaticomastoid regions extending toward the area of impact.

Comment. It is apparent, from the foregoing brief description of studies of threshold deformation, that the weakest area of the skull (area of primary stress level) following an impact at a given point may be determined by "stresscoat" analysis. The initial fracture line will occur in the area of primary stress level. Multiple fractures produced by increasing energies were found to conform to the pattern predicted by the stresscoating in areas of secondary and tertiary stress levels. It will be noted, in the analysis of experimental skull fractures, that in many of the specimens with stellate fractures, incomplete circular cracks appear, surrounding the areas of impact. The position of these circular fractures is not apparent in the threshold studies because the energies used were not sufficient to cause extensive inbending of bone. With a severe blow, the area of impact may be inbended and remain inbended, never to rebound to its original position. This is caused by failure of the skull in incomplete circular patterns, which may appear in several concentric rings around the point of impact (Figs. 10 and 11).

Experimental Skull Fractures in Cadaver Heads with Scalp and Content Intact

Embalmed cadaver heads freshly separated from the body were obtained from the anatomical laboratories. Deceleration impacts were administered in four areas: the midfrontal, the anterior interparietal, the midoccipital, and the posterior parietal regions. A total of 46 specimens was used. In these experiments, the role of the spinal column in its influence upon the head may have been unduly minimized. However, it was found that heads separated from the body were easier to handle and the control of energy absorption was more accurate. No direct correlation between the amount of energy absorbed by the head and the extent of bony damage was observed. This is primarily due to variations in thickness of the scalp and skull. The weight of the dry skull is a function of its thickness, and some degree of correlation seems to exist between this and the energy expenditure, as well as a resultant fracture. It was significant that in adult cadaver heads, fractures were obtained with as little as 400 inch-pounds of energy. It should also be noted that multiple lines of fracture may be obtained with amounts of energy not much higher than those producing single linear fractures. This suggests the important conclusion that, once the skull undergoes severe deformation with failure, only a little additional energy may be needed to cause complete destruction. Although one can estimate the position of a single fracture line quite accurately and possibly also the position of the next fracture line to appear, when greater energies are used it is impossible to foretell the position and the order of appearance of the other fractures because of the brittle nature of the skull.

Experimental Fracture with Midfrontal Deceleration Blows: Ten specimens were used in this group of experiments. There were three specimens with single linear fractures; two specimens with two linear

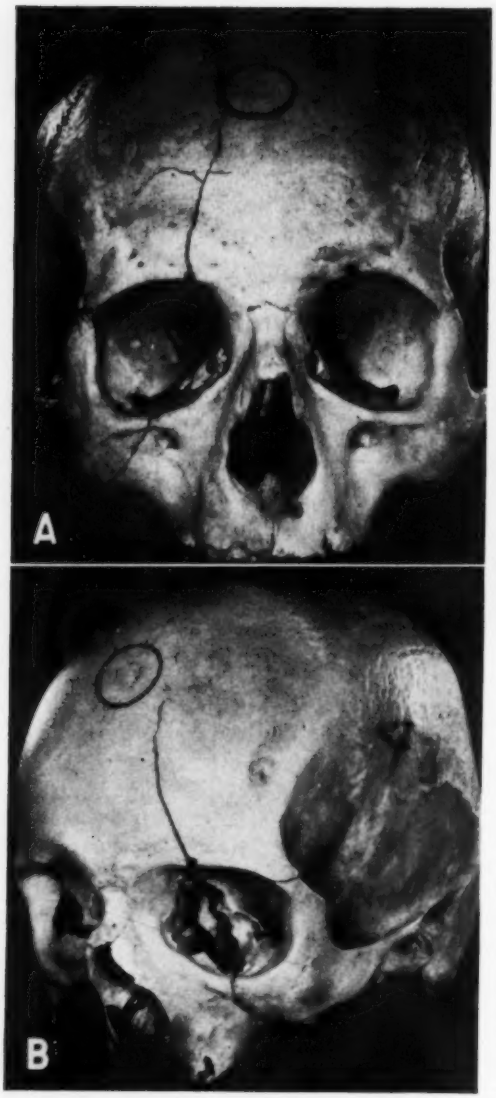

Fig. 10. Experimental skull fracture in cadaver heads: midfrontal blow. The photograph at the upper left (A) shows a linear fracture extending upward from the supraorbital notch to the region of impact. There is also a fracture of the maxilla in line with the fracture of the frontal bone. The lines of force resulting in this fracture pattern represent the area of primary stress level. In B, in addition to the fracture above described, a lateral frontal fracture is seen extending toward the zygomaticofrontal junction. This break represents the area of secondary stress level. In C, a more severe injury resulting in a stellate fracture is seen, with many cracks extending toward the region of impact, as well as circular patterns surrounding the area of impact and produced by inbending of the bone. There are at least five circular patterns. The radial cracks in the skull seen superiorly and laterally, which extend toward the circular pattern and are stopped by the latter, are due to tearing-apart forces on the internal surface of the skull produced by inbending.

fractures; and, five with extensive stellate fracture formations.

Figure 10 shows three examples of experimental fractures due to a midfrontal blow. In the specimen in A there is a single linear fracture extending upward from the supraorbital notch toward the point of impact. A fracture of the maxilla is also present, in line with the fracture of the frontal bone. In the specimen in B are two fracture lines, one extending from the supraorbital notch upward toward the point of impact and another in the lateral frontal region, extending toward the frontozygomatic junction. In C is shown a more extensive fracture of stellate variety, with many linear fractures extending toward the point of impact from the region of the orbits. There are also several concentric fracture lines, none of which is a complete circle. These concentric fractures are the result of failure of the bone due to extreme inbending at the time of impact. The bone fails on the external surface of the skull at the edge of the inbended region.

Fig. 11. Experimental skull fracture in cadaver heads: anterior interparietal blows. In A, there is a midfrontal fracture extending toward the point of impact (area of primary stress level). In B, there is, in addition, a fracture in the parieto-occipital region extending toward the point of impact, a little to the left of the midline (area of secondary stress level). In C, there is a stellate fracture with five main fracture lines extending toward the point of impact. There are also seen circular patterns, at least five in number, produced by inbending of bone. It should be pointed out that the linear fractures extending toward the region of impact reach the center of the area of impact and join with one another. Since the bone at the center of impact and, successively, the more peripheral regions surrounding the area of impact, became inbended never to return to the original position, the explanation for the extension of the fracture lines to the center of impact is to be found in the fact that the fracture lines from outbending join with fracture lines near the area of impact due to inbending.

In severe injuries resulting in stellate fractures, the stress caused by inbending of the bone also results in tearing-apart forces on the internal surface of the skull around the point of impact, with fracture lines of stellate distribution. Thus a fracture resulting from outbending of bone peripheral to the area of impact may become continuous with a fracture line initiated by extreme indending of the bone at the point of impact. As one studies the skull fracture patterns in C, one may be able to tell the order in which the various fracture lines have appeared, particularly those that cross each other. For instance, it is quite apparent that the fracture lines extending toward the point of impact from the roof of the orbit and the nasofrontal junction appeared before those which are at right angles to them. Otherwise the presence of the horizontal fractures should have prevented the further extension of the vertical fracture lines. It may also be noted that the fracture lines extending toward the concentric ring superiorly are stopped by the ring and do not extend any further. It

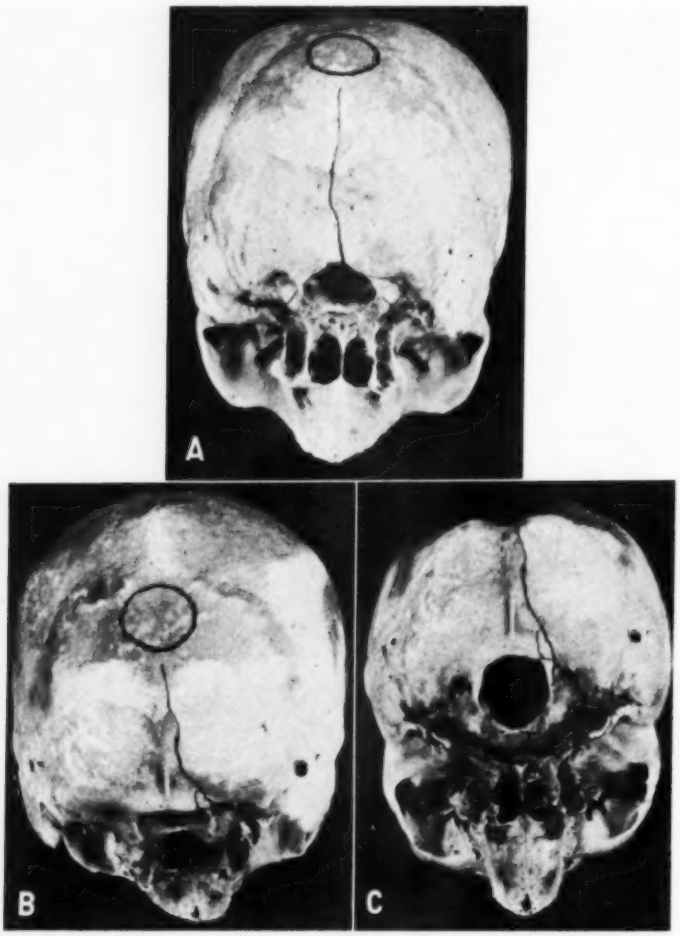

Fig. 12. Experimental skull fractures with cadaver heads: midoccipital blow resulting in linear fracture. In A, there is a linear fracture extending toward the point of impact from the middle of the foramen magnum. In B and C one sees a variation of the above, the fracture line extending upward toward the point of impact from a position lateral to the foramen magnum.

may be concluded that these fracture lines were initiated at the same time or after the concentric ring fracture. The radial fractures extending into the semicircular fracture were initiated on the internal surface of the skull from tensile stresses due to inbending.

Experimental Fracture with Anterior Interparietal Blows: Seventeen specimens were used in these studies. There were four examples of single, linear fractures; three examples of two lines of fracture, and ten stellate fractures.

In Figure 11 a single fracture line, two fractures, and a stellate type of lesion are shown. In the specimen in A, the fracture line extends from the nasion toward the point of impact at the midline. In B two lines are seen to extend toward the point of impact, one from the region of the nasion and the other from the parieto-occipital region slightly to the left of the midline. The stellate type of fracture is seen in C, showing five main fracture lines extending toward the point of impact. It is important to note that these fracture lines all join

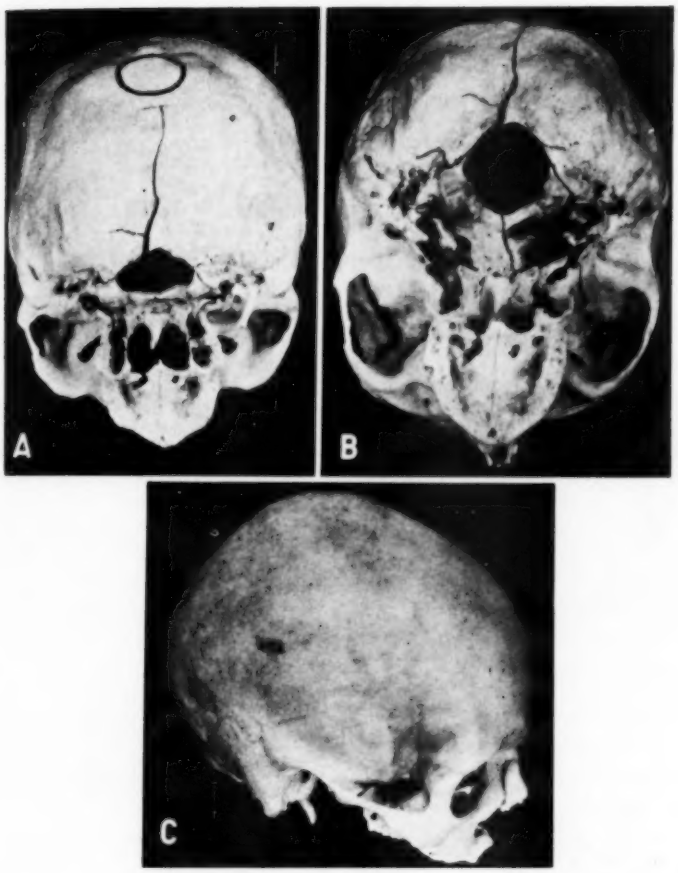

Fig. 13. Experimental skull fracture in cadaver heads: midoccipital blow resulting in extensive fracturing of the base. A fracture line extending from the middle of the foramen magnum toward point of impact is seen in A. In B, there is also a fracture of the basilar process of the occipital area and a more lateral fracture crossing the petrous bone, extending into the middle fossa, and ending in the temporal region on the right side. In C, the termination of the fracture line in the right temporofrontal junction is seen.

in the region of impact. There are also five concentric fractures, none of them complete circles, which were undoubtedly produced by extensive inbending with failure at the borders of inbended and not-yet-inbended bone. It is obvious that the bone did not rebound following impact, due to failure in concentric fracture lines.

The presence of the fracture lines extending toward the point of impact and joining with one another may be explained as follows. With severe inbending there is not only failure of bone in concentric curvilinear fractures, but there is also fragmentation of the bone surrounding the area of impact, with fractures extending radially to the region of the first concentric crack. These fractures are caused by inbending of bone and are similar to those seen in depressed fractures. With low-velocity blunt blows, the linear fractures initiated by outbending of bone away from the region of impact become continuous with the fracture lines in the inbended area.

Experimental Fractures Resulting from Midoccipital Blows: Deceleration impacts were administered to the midoccipital re-

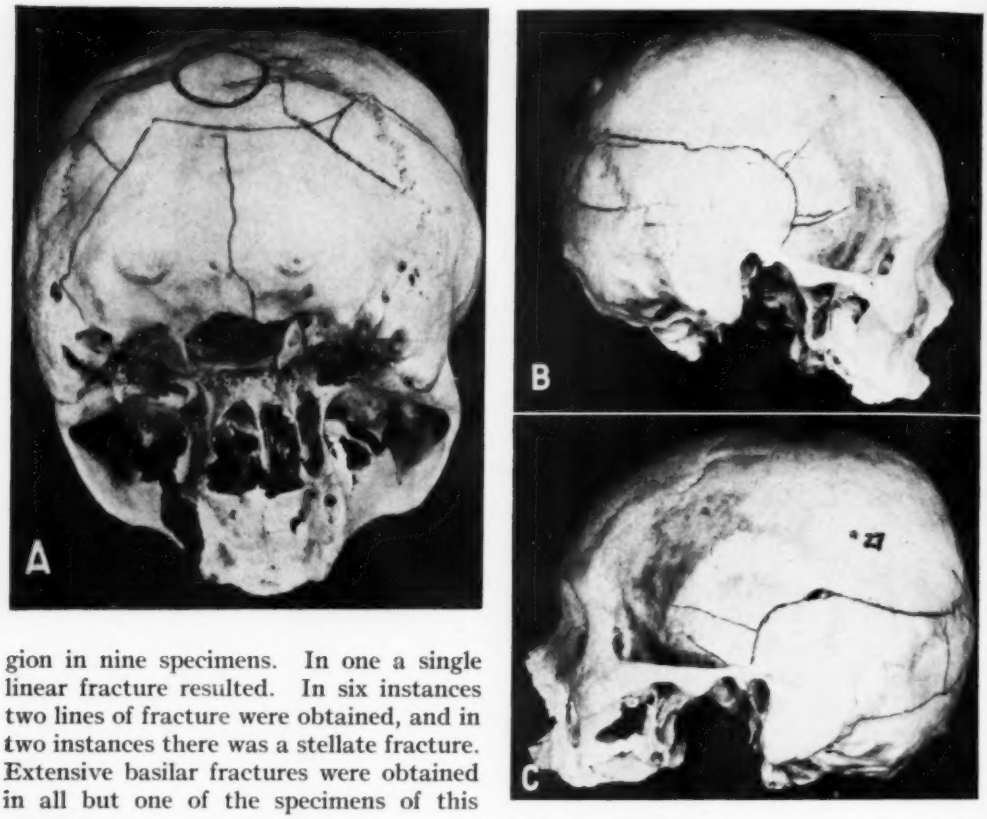

Fig. 14. Experimental skull fracture in cadaver heads: midoccipital blow resulting in a stellate fracture. A midoccipital fracture extending toward the point of impact from the middle of the foramen magnum and parieto-occipital fractures directed toward the point of impact from both sides is shown in these photographs (area of tertiary stress level). A curvilinear pattern just anterior to the area of impact was undoubtedly produced by tearing-apart forces at the junction of inbended and not-inbended bone at the time of impact.

gion in nine specimens. In one a single linear fracture resulted. In six instances two lines of fracture were obtained, and in two instances there was a stellate fracture. Extensive basilar fractures were obtained in all but one of the specimens of this group.

In A, in Figure 12, a single linear fracture is seen, extending from the middle of the foramen magnum toward the point of impact in the region of the external occipital protuberance. A variation of this lesion is shown in B and C in which the fracture extends upward toward the point of impact from a region lateral to the foramen magnum. In both instances, there is some fracturing of the borders of the foramen magnum with involvement bilaterally of the condyloid process. Figure 13 shows extensive involvement of the base of the skull with one fracture line crossing the basilar process of the occipital bone into the anterior fossa and the other fracture line bisecting the petrous bone and extending all the way to the anterior and lateral aspect of the temporal bone on the right side. The line of fracture which seems to stop the progress of the midline occipital fracture near the area of impact is undoubtedly due to tensile stress on the external surface of the skull at the border of the inbended bone.

In Figure 14 an extensive stellate fracture from a midline occipital blow is pictured. We now see fracture lines extending toward the point of impact from the parieto-occipital regions on both sides. Anterior extensions of the fracture lines are present in the temporal region. A curvilinear fracture surrounding the area of impact on the foramen magnum side is the result of

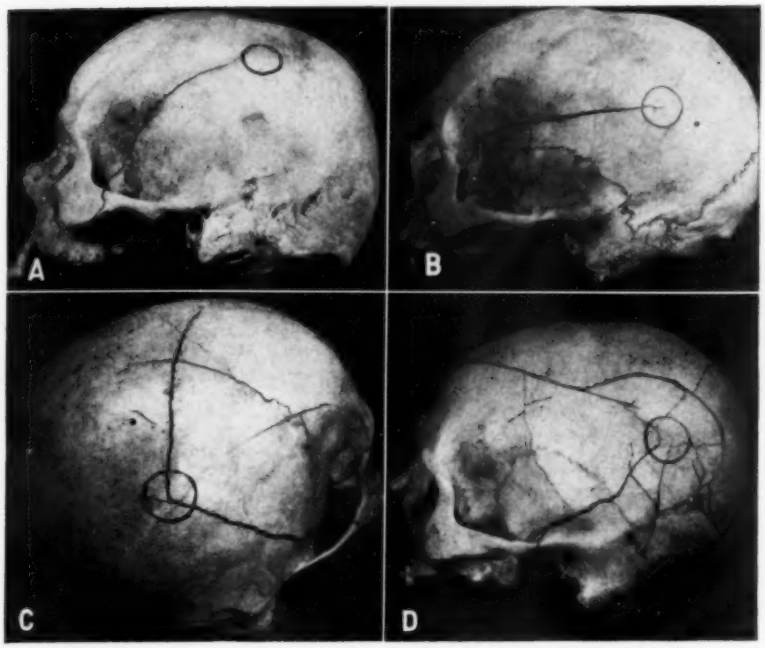

Fig. 15. Experimental skull fracture with cadaver heads: posterior parietal blows. In A, is a single linear fracture extending upward from the temporal region toward the region of impact. There is also a fracture of the zygomatic arch in this instance in line with the linear fracture of the temporoparietal area. In B, there is a linear fracture extending posteriorly and toward the point of impact from the temporofrontozygomatic region, with another line joining it from the temporal region. The tearing-apart forces resulting in this fracture represent the area of secondary stress level. In C, there are two main fracture lines due to an impact in the right posterior parietal region and a beginning third fracture line between the two. The fracture lines joining these linear fractures just described are caused by inbending of bone and occurred at the junction of the inbended area with the not-inbended area of bone. In D, there is a stellate pattern, with fracture lines extending toward the region of impact. There is also a circular pattern surrounding the medial, posterior, and inferior aspect of the area of impact. In this part circle are cracks extending toward the center of impact, undoubtedly caused by inbending of bone. It is to be noted that these cracks become continuous with fracture lines caused by outbending of bone at a distance from the area of impact.

tensile stress on the external surface of the skull at the junction of inbended and not-yet-inbended bone. Since two fracture lines extend to this region and stop without crossing the curvilinear fracture, it is safe to assume that the latter occurred just before the occipital and mastoid fractures reached this region.

Experimental Skull Fractures with Posterior Parietal Blow: Posterior parietal blows were administered in ten specimens, divided between the right and the left sides. In two instances, single linear fractures were obtained, in two, two lines of fracture, and in the remaining six a stellate pattern.

In Figure 15, A shows a skull in which a posterior parietal blow on the left side resulted in a single linear fracture extending up from the temporosphenoid junction toward the point of impact. It should be noted that there is also a fracture of the zygomatic arch in this instance, due undoubtedly to the outbending caused by separation of the mastoid and the malar regions, respectively. In B there is a two-line fracture from a blow in the posterior parietal region on the right side. In C a three-line fracture due to a right posterior parietal blow is shown, and in D a stellate type of fracture, the result of a blow in the posterior parietal region on the left side.

In this last specimen it should be noted that several lines of fracture extend toward the area of impact. That area has been inbended in a circular manner, posteriorly and superiorly, resulting in a rather extensive fracture line. It is due to the inbending tensile stress concentration on the inner surface that the bone has fractured in at least five places between the circular fracture and the area of impact. That fracture lines caused by inbending join with those due to outbending can be seen in this figure.

Comment: Thus far, only four regions have been studied by the experimental method. In general, experimental fractures occur in positions predicted by the "stresscoat" technic. Although single linear fractures and stellate fractures are quite easy to obtain, the intermediate type, such as a two-line fracture, is difficult to produce. This is explained by the fact that while it takes a large initial expenditure of energy to cause failure of the skull, it is almost shattered by the addition of a small percentage of the original force. Once initial failure has taken place, the stress distribution characteristics of the skull have changed and a little additional energy produces generalized failure. That the skull behaves as a brittle material, when the amount of energy expended upon it is large, is apparent.

Comminution of fragments is noted, particularly with extensive fracturing. This is the result of a combination of the tearing-apart forces of inbending on the internal surface of the skull, immediately beneath the area of impact, and tearing-apart forces at the junction of inbended and not-yet-inbended bone of the external surface causing concentric patterns, usually not complete circles. With severe injuries, as the bone is inbended farther, concentric cracks appear successively around the area of impact, the closest concentric ring first, the next closest second, and the one farthest out last. In the area of inbended bone immediately beneath the point of impact, tensile stress concentrations occur on the internal surface of the skull, tending to fragment the inbended bone into several pieces, by fracture lines extending radially from the center of impact. The fracture lines thus produced may join with others extending toward the region of impact from a distance and resulting from outbending of bone.

In the study of fracture lines in this experimental group, it has been seen repeatedly that, when the tensile stress is parallel to a buttress, the fracture line will cross the buttress and bisect it. On the other hand, if the buttress makes an acute angle with the direction of the tensile stress, the direction of the path of the resulting fracture line may be somewhat affected by it.

The fractures at the base of the skull follow a certain pattern. With blows in the occipital region, the tearing-apart forces at the base of the skull are from side to side. When the blow is in the parietal or lateral frontal region, the tearing-apart forces are anteroposterior in direction, so that the fracture may extend from the middle fossa on the one side to the middle fossa on the other. With blows in the frontal region, the tearing-apart forces are from side to side, with an inclination medially. Fractures in the anterior fossa resulting from lateral frontal and anterior parietal blows usually extend from one side to the other.

There has been some variation in the position of greatest weakness (area of primary stress level) and the resultant fracture from blows in a given area. Whereas with some specimens, a temporoparietal fracture is obtained with a blow at the anterior interparietal region, in other specimens a midline frontal fracture is obtained. A statistical study is now in progress to determine the percentage of such variations.

On the basis of the "stresscoat" observations and the experimental skull fractures in cadaver heads, it may be stated that one can foretell the position of the primary and secondary fracture lines based upon the location of impact. To foretell

Fig. 16. Correlation of clinical cases of fracture of the skull with "stresscoat" studies. In A, a midfrontal blow is shown to result in tearing-apart forces from side to side at the nasofrontal junction. B and C are roentgen studies in a patient who sustained a deceleration impact in the midfrontal region, resulting in a fracture line in the midline of the frontal bone as well as a fracture line in the midparietal occipital area. This fracture pattern is similar to the two fracture lines seen in Fig. 11, left lower photograph.

the order of appearance of the other fracture lines in a stellate fracture due to the expenditure of additional energy is most difficult, because of the brittleness of the skull.

Clinical Skull Fractures

During the past two years, clinical fractures seen mainly in the Receiving and Grace Hospitals (Detroit) have been studied. The area of impact was noted and correlated with the resulting fractures in the light of the studies with "stresscoat."

Single linear fractures occur in almost 30 per cent of the clinical cases of skull fracture one sees in the larger services. In many, the area of impact is not discernible. In others, it may be indicated by a bruise or a laceration of the scalp. It must be borne in mind, however, that frequently a tearing or bruising of tissue may take place in one phase of an injury followed by a more solid blow in a region other than the area of scalp damage. Even with these reservations, the material studied proved useful in elucidating the mechanism of linear skull fracture.

Clinical examples of linear skull fractures occurring from blows in various parts of the skull have been selected. The area of impact in most of the illustrations is represented with a circular radiopaque wire.

In Figure 16 are shown the stress patterns (A) following a midfrontal blow near the bregma and two roentgen studies (B and C) of skull fractures. Tearing-apart forces from a blow in the midfrontal region are evident at the nasofrontal junction in the midline in the "stresscoat" preparation. The roentgenograms are those of a patient who was suddenly decelerated when the car he was driving ran into a railroad embankment, and the midfrontal area of the head struck the windshield. A linear fracture in the midline nasofrontal junction extends toward the point of impact. A midline occipitoparietal fracture is also seen extending toward the point of impact. These fracture lines are very similar to the experimental fractures in Figure 11, illustrating areas of primary and secondary stress level.

In Figure 17 the insert shows an area of impact, outlined in ink, in the frontal bone to the left of the midline over the left eye. To the left (A) is shown a stress pattern from a blow of this type with resultant tearing-apart forces in the lateral-frontal and frontotemporal regions. In the roentgenogram (B) a slight depression may be seen in the region of impact, and a linear fracture paralleling the stress pattern in the "stresscoat" preparation. Although there was a slight depression, general deformation of the skull, nevertheless, took place, resulting in tearing-apart forces in

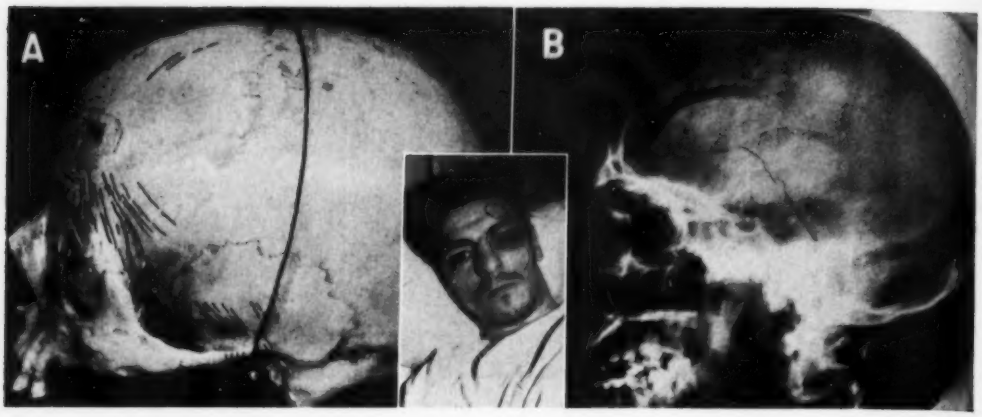

Fig. 17. Insert shows the area of impact in the frontal bone to the left of the midline. The "stresscoat" pattern (A) suggests tearing-apart forces in the lateral frontal and frontotemporal areas. The actual fracture lines in this case (B) follow stress patterns for impact in this region. There is a fissure fracture with slightly depressed borders at the point of impact. This exemplifies a type of depression which may be associated with generalized deformation of the skull, resulting in linear fracture from outbending of bone at a distance from the area of impact

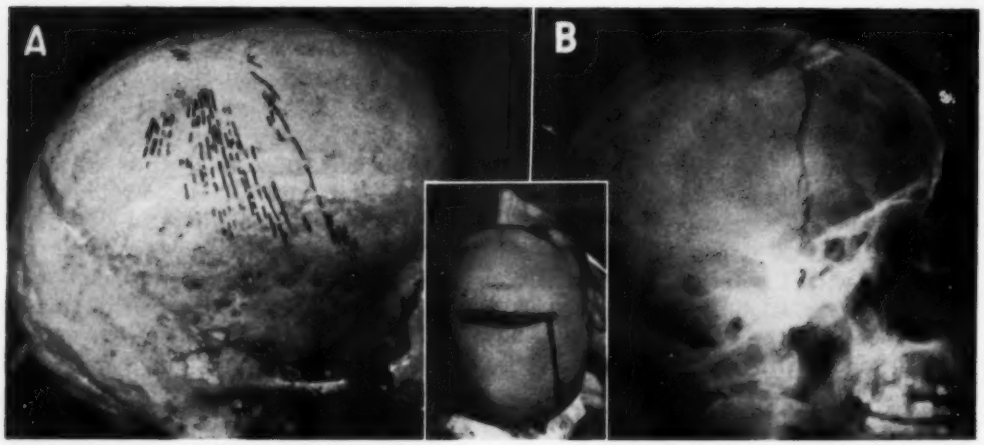

Fig. 18. Anterior interparietal blow causing a slight depression in the area of impact with fracture lines (B) extending toward the area of depression in both temporoparietal regions, paralleling the stress patterns seen in A.

the lateral-frontal and frontotemporal regions, eventuating in a fracture line.

Figure 18 illustrates a compound skull fracture due to an anterior interparietal blow, with a slight depression at the area of impact. A blow in this region is usually associated with tearing-apart forces in the temporoparietal regions, on one or both sides, the forces acting in the anteroposterior direction, as seen in the "stresscoat" preparation (A). The roentgenogram (B) shows fracture lines extending into the region of the impact in both temporoparietal regions in a manner similar to the "stresscoat" lines in the dry skull preparation. Although there is a depression in this instance, yet the blow was of sufficiently low velocity to cause inbending and outbending of the skull, resulting also in fractures from outbending at a distance from the point of impact.

The patient who is shown in the insert in Figure 19 was run down by a car and his head struck the sidewalk. The region of

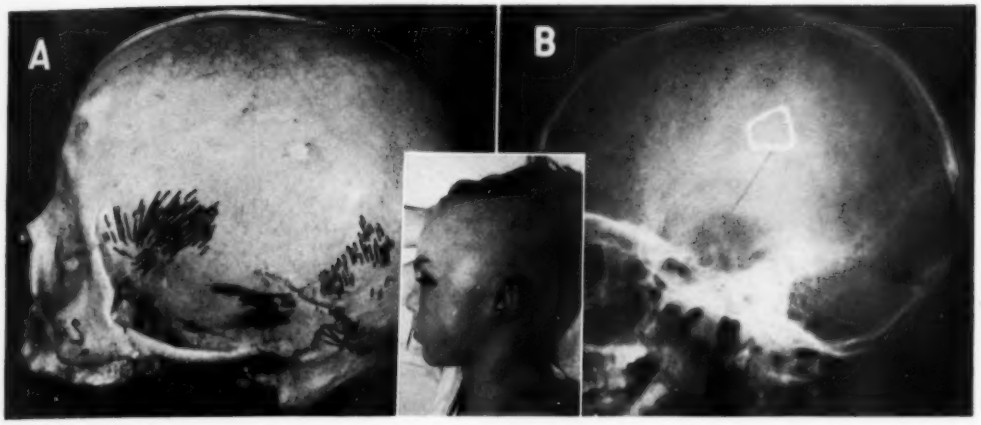

Fig. 19. The boy shown in the inset was struck in the left parietal area. The area of impact was made radiopaque with the use of a wire, as shown in B. The fracture line is seen to extend toward the point of impact in a manner similar to the stress pattern seen in A.

impact, in the left parietal area, is made visible in the roentgenogram (B) with the use of a radiopaque substance. The skull fracture extends upward and backward toward the point of impact from the anterior temporal region, paralleling the "stresscoat" pattern in the parietotemporal area as shown in A. This region is found to be the area of primary stress level, and a single linear fracture from an anterior parietal blow would be initiated in the anterior temporal region, extending upward and backward.

In the case shown in Figure 20 the area of impact was in the posterior parietal region, represented by the circular radiopaque wire shadow, with a temporoparietal fracture extending upward and backward toward the point of impact. This patient, who had a subdural hematoma on the left side, received his injury on falling to the sidewalk in an attack of epilepsy. The area of impact was well shown by a localized bruise in the posterior parietal region on the left side.

The area of impact in the case shown in Figure 21 was in the right parietal region above the ear, with a fracture line extending from the occipital region upward and forward toward the point of impact, as shown in B. To the left (A) is a "stresscoat" pattern from a blow in this region, resulting in tearing-apart forces about the

Fig. 20. This patient sustained a skull fracture in an epileptic fit. Trephine openings were made to evacuate a subdural hematoma. The area of impact is shown with a circular radiopaque wire. The fracture extends from the temporal region upward and backward to the point of impact. The "stresscoat" pattern following a posterior parietal blow showing the area of primary stress level may be seen in Figure 8.

area of impact. A blow in the posterior parietal region is usually associated with a fracture originating in the anterior temporal region and extending upward and backward as previously illustrated. The fracture shown in this patient is a variation. Such variations do occur and deserve notation.

In the case shown in Figure 22 the area of impact was on the back of the head,

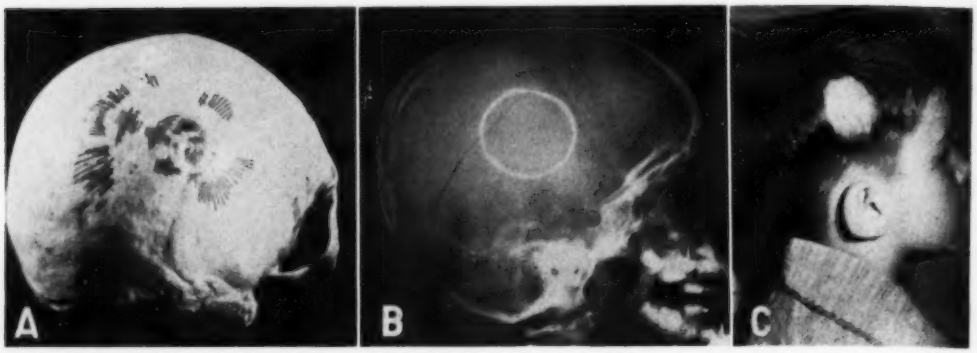

Fig. 21. A right parietal blow with a fracture line extending upward and forward toward the region of impact (B). This is a variation of the usual pattern. "Stresscoat" studies (A) show that such a variation is possible in some specimens.

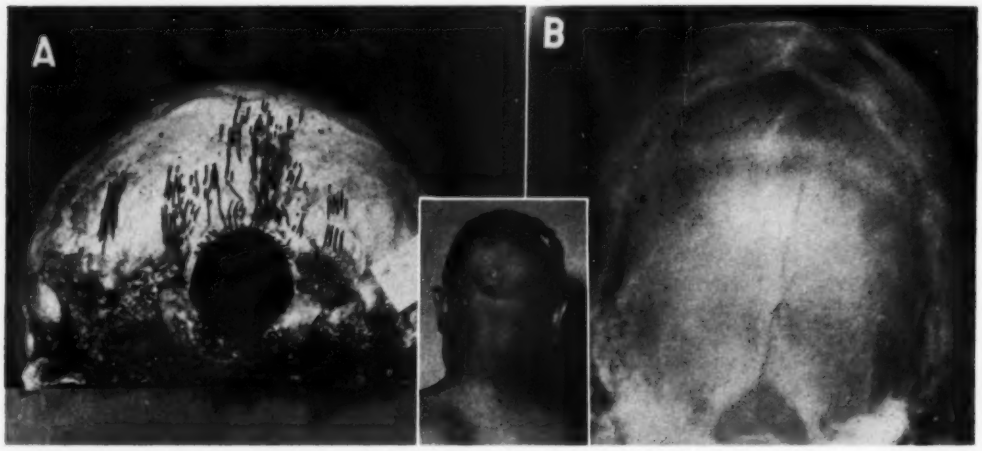

Fig. 22. Skull fracture (B) extending from the middle of the foramen magnum to the point of impact, which may be seen in the inset photograph of the patient. The "stresscoat" pattern due to a midoccipital blow (A) suggests tearing-apart forces from side to side, resulting in a fracture of the base of this type.

slightly to the left of the midline and just above the occipital protuberance, resulting from a fall on the pavement. The "stresscoat" pattern from a blow in this region is shown in A, illustrating tearing-apart forces from side to side involving the occipital base. The roentgenogram (B) shows a linear fracture extending upward from the middle of the foramen magnum and stopping at the point of impact. It may be noted that the fracture is wider at the foramen magnum than near the area of impact. The fracture was initiated in the former region and then extended toward the latter, as well as in the opposite direction.

Figure 23 is the roentgenogram of a patient who was hit upon the back of the head with the handle of a gun. A fracture line extends from the region lateral to the foramen magnum toward the point of impact, which has been outlined.

Comment: The clinical examples just described support the concepts obtained from a study of the "stresscoat" preparations. A single linear fracture is initiated away from the point of impact and extends toward the point of impact as well as in the opposite direction. The extension of the fracture line up to the center of the area of impact may be explained on the basis of tensile forces in this region from out-

bending of the skull, as explained in the earlier part of this paper. When more energy is used than required for the production of a single linear fracture, other breaks may appear in the bone in areas of secondary and tertiary stress level. With adequate energy, a stellate type of fracture may be obtained, as has been shown in the study of experimental fractures. As a result of inbending about the point of impact, fractures may be initiated on the inner surface and radiate out from the site of the blow. The fracture or fractures in the skull resulting from outbending and initiated at a distance from the point of impact may join with a fracture resulting from inbending at or near the point of impact. Thus, a more complicated mechanism is in operation in severe injuries of the bone producing stellate fractures than in less severe injuries resulting in single linear fractures.

Fig. 23. X-ray film of a patient who was hit on the back of the head with a gun. The area of impact was just above and two inches behind the left ear. This region is shown with radiopaque wire surrounding it. The fracture line is seen to extend toward the point of impact from a position lateral to the foramen magnum.

DISCUSSION

With the use of the "stresscoat" it has been possible to delineate the areas of primary, secondary and tertiary stress level following blunt blows. The area of primary stress level is the weakest region and denotes the position of a possible break in the bone if adequate energy is expended. If more energy is expended than necessary to cause a single linear fracture, a second line of fracture may appear in the area of secondary stress level as shown by the "stresscoat" studies. If still more energy is expended, a stellate fracture is obtained with fracture lines radially arranged around the point of impact.

Both in this study and in previously reported work it has been shown that a blow in a given region may result in tearing-apart forces in one area in a given specimen, and in a different region in another specimen. The area of primary stress level may be in different regions following a blow in the same area in different specimens. Thus a midline frontal fracture may result from an anterior interparietal blow in one specimen and a temporoparietal fracture, paralleling the coronal suture, may occur in another. At the present time, work is being done to determine the actual statistical variations in the position of areas of primary stress level for blows in a given area.

In previous work on the mechanism of linear skull fracture, the energies utilized were insufficient to cause a depression of the bone. In the present group of experiments, higher energies have been used, resulting in failure of the bone around the point of impact from inbending. This failure follows the pattern seen in the "stresscoat" experiments. The inbended area immediately around the point of impact undergoes fragmentation by radial fracture lines extending from the point of impact, failure occurring from tensile stresses on the internal surface of the skull. There may be three to six such lines of fracture. There is also failure of the bone on the external surface of the skull at the junction of inbended and not-yet-inbended bone. In flat surface deceleration impacts, the greater the energy, the greater the area

of bone which is ultimately inbended never to rebound into its former position. Failure under these circumstances occurs in circular or curvilinear patterns, with the cracks appearing at different distances from the center of impact, denoting the extent of the inbending.

The size, shape, and velocity of the injuring object, as well as the contour, thickness and "chance characteristics" of the bone structure, are important in the mechanism of skull fracture. "Chance characteristics" of bone structure include unusually large diploe, pacchionian defects, unusual venous channels between the outer and inner plates of the skull, and unusually thick areas of bone. These influence the production and propagation of fracture lines.

A blunt blow causes an area of inbending at impact. This inbended area may rebound if the blow is not severe enough to cause a depression. The mechanism of fracture is different with depression and in those cases in which the area of inbending rebounds. If the inbending is not severe enough to cause a depression, there are usually areas of selective outbending of the skull peripheral to the area of inbending. As has been stated, a linear fracture due to tearing-apart forces resulting from outbending of the skull is initiated away from the point of impact and extends toward the point of impact and in the opposite direction. If more energy is used, two lines of fracture may be seen to extend toward the region of impact, from the areas of primary and secondary stress levels. If the inbending is severe enough to cause a depression, then, depending upon the rate of energy absorption in the region of impact, there may or may not be significant outbending distant from the area of impact. The more rapid the blow, the less the distant outbending and the more localized the area of depression which is produced. The area of depression is fragmented by radial fracture lines extending out from the center of impact. These radial fracture lines in a depression are due to tensile stresses from inbending and are initiated on the internal surface of the skull.

A deceleration blow upon a flat surface results in a stellate fracture if the energy is optimal. Usually in stellate fractures, the area of inbending about the point of impact fails, with resultant depression of bone and fragmentation by radial fracture lines three to six in number, from tensile stresses on the internal surface of the skull. Simultaneously, fracture lines are initiated at a distance from the point of impact, resulting from tensile stresses on the external surface of the skull due to the outbending. These fracture lines from outbending may become continuous with the radial fractures in the area of depression which result from inbending. With a flat surface blow, if the energy is adequate, there is failure of the bone from inbending immediately around the point of impact, and as the inbending progresses, the bone fails at the junction of inbended and not-yet-inbended bone, resulting in semicircular or curvilinear fracture lines at various distances from the point of impact. These semicircular fractures are initiated on the external surface of the skull.

Basal fractures will be the subject of another study. In general, it has been observed that fractures extending into the base of the skull from blows in the anterior aspect and the posterior aspect of the head involve the base anteroposteriorly or postero-anteriorly with tearing-apart forces from side to side. Fractures resulting from blows on the lateral aspect of the skull traverse the base of the skull from side to side. However, it is quite apparent that the base of the skull is very fragile, and only rough estimates can be made of the possible course of fracture lines. Finer ramifications cannot be foretold by any means at our disposal at the present time.

The mechanism of the formation of a depressed skull fracture will now be discussed. There are six varieties of depression based upon the velocity and, to a lesser extent, the shape of the injuring object. (1) A rapidly moving missile may perforate the skull, resulting in fragments

of bone being indriven into the substance of the brain. (2) A more rapidly moving object may not only perforate the skull but may cause shattering of the bone from radial acceleration imparted to the contents, resulting in tremendous increase in intracranial pressure (bursting fracture in high-velocity bullet wounds). (3) A fairly rapidly moving blunt object, such as a baseball, brick, or hammer, may cause an area of depression in which most of the expended energy is absorbed in producing the depression. Under these circumstances there is inbending of an oval or circular area of bone with fragmentation by three to six radial fractures and separation of the inner and the outer tables. The border of the oval or circular area usually presents a curvilinear fracture which is caused by tearing apart forces on the external surface of the skull at the junction of the inbended and not-inbended bone. The fragmentation of the area of depression roughly follows the pattern shown by the "stresscoat" on the internal surface of the skull around the area of impact. With such a blow there may be no other fractures. (4) A slowly moving object, causing a localized blow upon the skull, may produce a depression with simultaneous deformation in regions other than the area of impact. There may also result one or two linear fractures extending toward the area of impact, due to tearing-apart forces from outbending of the skull. (5) A slowly moving object, fairly sharp or pointed in contour, may cause an area of depression more or less patterned after the shape of the object. Under these circumstances, general deformation of the skull may or may not be present. If the energy is mainly absorbed at the point of impact, only the area of depression is obtained. Otherwise there may be associated fractures from outbending of the skull. (6) Depression by a slowly moving, high-kinetic-energy, blunt surface results in extensive comminution with radial fracture lines extending from the center of impact and circular fracture lines at varying distances around the area of impact. This type was frequently seen in this study.

There may be some misgivings as to the accuracy of the experimental observations on cadaver heads, with contents and scalp intact, and the similarity of the fractures obtained to those in the living. In previous work it was found that the stress patterns in the living dog and monkey under anesthesia are essentially similar to those of the dead animal with skull contents intact and in dry skulls of the same specimen. The "stresscoat" patterns of the human cadaver skulls, with scalp freshly removed, and of the dry skull were similar in direction and distribution. Strain gauge studies of the living animal under anesthesia and the dead animal with skull contents intact are similar. In the experimental skull fracture work with cadaver heads freshly obtained from the anatomical laboratories, the fracture lines are similar to those seen in roentgenograms in human head injuries. It is therefore quite reasonable to assume that the findings in experimental skull fractures of cadaver heads are essentially similar to those in the living. That there is a difference in scalp thickness from absorption of embalming fluid may well be noted from the differences in thickness in the various specimens previously mentioned. It cannot be denied that the skull contents are different in the cadaver and the living, but with low-velocity impacts, the contents have practically no effect upon the deformation patterns, as shown experimentally. That the range of energy absorption resulting in fracture may be different in the living is quite possible, but the figures for cadavers (400 to 855 inch-pounds) must be approximately those that may cause similar damage in the living. In the case of a depressed fracture due to a baseball injury, the total energy absorption is computed to be in the neighborhood of 600 inch-pounds of energy.[2] We have been able to obtain in forty-six cadaver experiments, fracture

[2] Using 100 feet per second as the velocity of a fast pitch, the kinetic energy of a 5 1/4 ounce baseball is $1/2\ Mv^2 = 615$ inch-pounds.

lines with as little as 400 inch-pounds of energy. In one specimen, we were unable to obtain a fracture with as much as 1100 inch-pounds of energy. There is some degree of correlation between the thickness of the skull (therefore its weight) and the amount of energy required to cause a fracture.

SUMMARY

1. The skull surface has been divided into twelve regions, and the stress patterns resulting from blows in each region have been analyzed with the aid of a brittle lacquer.

2. Areas of primary, secondary, and tertiary stress levels have been plotted for the twelve regions.

3. Following impact, the area of primary stress level is the weakest region in the skull and it is the place where a fracture may be initiated with adequate energy. The area of secondary stress level is the region where a second fracture line may be initiated with additional energy. The areas of tertiary stress level are the regions where further fracture lines will be caused with expenditure of still more energy, resulting in a stellate pattern.

4. The area of primary stress level may be in different regions in different skulls.

5. The mechanism of linear, stellate, comminuted, and depressed fractures has been described.

6. Buttresses are no hindrance to the propagation of fracture lines, provided the buttress is parallel to the tensile stress in the bone.

7. Blows on the anterior and posterior aspects of the head cause tearing-apart forces at the base, from side to side, resulting in fractures which traverse the base anteroposteriorly or postero-anteriorly. Parietal and lateral frontal blows cause tearing-apart forces at the base, anteroposteriorly. Fractures traverse the base from side to side with parietal and lateral frontal blows. The base of the skull is found to be extremely brittle.

8. With experimental skull fracture in cadaver heads, a single linear fracture has been obtained with as little as 400 inch-pounds of energy.

9. In clinical cases of head injury where the position of the blow is known, the resultant fracture line is found in a position and direction predicted by the "stresscoat" study.

10. The position of the fracture may be used to tell accurately the position of the blow.

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SUMARIO

El Mecanismo de las Fracturas Craneales

Dividida la superficie del cráneo en doce regiones, analízanse, con la ayuda de un barniz quebradizo, los moldes o formas de tensión debidos a golpes recibidos en cada región. Las zonas de niveles primarios, secundarios y terciarios de tensión han sido trazadas para las doce regiones.

A continuación del choque, la zona de nivel primario de tensión es la región más débil del cráneo y el sitio en que puede iniciarse una fractura si la violencia es adecuada. La zona de nivel secundario de tensión es la región en que puede iniciarse otra línea de fractura, imprimiendo más violencia. Las zonas de nivel terciario de tensión son las regiones en las que se pro-

ducirán nuevas líneas de fractura, aplicando todavía más violencia, y dando por resultado un molde o patrón estrellado. La zona de nivel primario de tensión puede quedar en diversas regiones en distintos cráneos.

Descríbese el mecanismo de las fracturas lineales, estelares, cominutas y deprimidas.

Los refuerzos no vedan la propagación de las líneas de fractura, siempre que el refuerzo sea paralelo al esfuerzo tensil en el hueso.

Los golpes en las caras anterior y posterior de la cabeza inician fuerzas desgarradoras en la base, de lado a lado, dando por resultado fracturas que atraviesan la base anteroposterior o posteroanteriormente. Los golpes parietales y laterofrontales inician fuerzas desgarradoras en la base, anteroposteriormente, y las fracturas ocasionadas atraviesan la base de lado a lado. La base del cráneo resultó ser sumamente frágil.

En las fracturas experimentales del cráneo en cabezas de cadáveres, se obtuvo una sola fractura lineal con una violencia que no pasaba de 400 pulgada-libras.

En los casos clínicos de lesión cefálica en que se conoce la posición del golpe, la línea de fractura resultante queda en una posición y dirección indicadas por el estudio de la "capa de tensión."

Puede usarse la posición de la fractura para localizar exactamente la del golpe.

Anomalous Right Subclavian Artery[1]

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ANOMALOUS RIGHT subclavian artery, originating as the last vessel from the aortic arch, is one of the commonest anomalies of the great vessels. Anatomists have been familiar with this condition for more than two centuries, yet few clinicians are aware of its existence. Despite its frequency and the ease with which it can be detected roentgenologically, the correct diagnosis is seldom made during life. This is due, in part, to the fact that the anomaly is usually asymptomatic. Occasionally, however, severe symptoms may develop and progress to a fatal outcome.

This anomaly has assumed greater significance with the advent of the surgical approach to the treatment of congenital malformations of the heart and great vessels. Gross (12), in 1946, successfully ligated an anomalous right subclavian artery. Since that time he has surgically cured 4 additional patients with symptoms related to this cause (13). Blalock (5) encountered the anomaly five times during operations on patients with the tetralogy of Fallot, but the abnormal position of the artery did not interfere with its use for the anastomosis. Humphreys, however, discussing Blalock's paper, stated that he had lost one patient during the Blalock operation because the right subclavian artery was anomalous.

Although Bayford (4) is usually credited with the first description of this condition in 1789, Holzapfel (18) gives priority to Hunauld for his account in 1735. Bayford applied the term *dysphagia lusoria* to the presenting complaint in his patient, "from the *lusus naturae* (freak of nature) that gives rise to it." In 1936, Kommerell (19) reported the first case diagnosed by roentgen methods.

INCIDENCE

In Maude Abbott's series of 1,000 autopsied cases of congenital heart disease (1), anomalous right subclavian artery occurred seven times. Various authors have reported the incidence in autopsy series as from 0.4 up to 2.0 per cent. Cairney (6), in a review of the literature up to 1924, found more than 230 cases.

In the few instances in which it was diagnosed during life, the anomalous artery was detected by roentgenologic methods. Individual cases have been reported by Kommerell (19), Zdansky (26), Günsel (15), Copleman (7), and Stauffer and Pote (23). Dahm (8) reported 2 cases. Brean and Neuhauser (27) reported 15 cases in 1947, and since that time have seen approximately 15 more (21). During the past two years we have encountered 9 patients in whom the typical roentgen findings were present.

EMBRYOLOGY

In the five-week embryo there are 6 pairs of arches connecting the ventral and dorsal paired aortas (7). During the normal development of the fetus, certain segments of this network of vessels disappear, while other branches persist to form the aorta and main arteries (Fig. 1). Thus, the right and left third arches enter into the formation of the right and left carotid arteries, respectively; the left fourth arch forms the aortic arch; the right fourth arch contributes to the formation of the right subclavian artery; and the sixth pair of arches forms the pulmonary arteries.

Alteration of this sequence of events produces various anomalies of the aorta and its branches. The anomaly of the right subclavian artery is believed to be the

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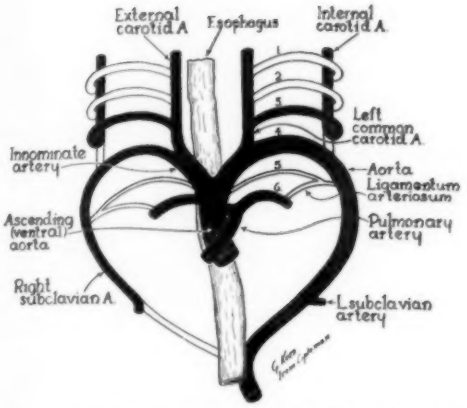

Fig. 1. Diagram of normal embryological development of aorta and main branches (after Copleman). The vessels which persist are in solid black.

result of abnormal disappearance of the right fourth arch, the artery then developing from a persistent right dorsal aorta (Fig. 2). The right subclavian artery thus no longer communicates with the ascending aorta, but arises as the last branch from the aortic arch. There is often a dilatation or *diverticulum* of the aorta at the origin of the anomalous vessel. This diverticulum is believed to be a remnant of the right dorsal aorta.

Brean and Neuhauser (27) stated that the process of aortic arch formation occurs in the second fetal month. They reported 2 cases of aberrant right subclavian artery associated with patent ductus arteriosus, in each of which the mother had suffered from a virus infection during the second month of pregnancy.

ANATOMICAL CONSIDERATIONS

The anomalous right subclavian artery usually arises from the distal portion of the aortic arch, about 1.5 cm. distal to the origin of the left subclavian artery. The exact point of origin varies (11). Stauffer and Pote (23) stated that "the origin is usually from the posterior wall of the aortic arch where it approaches the vertebral column, and more rarely from the upper wall. If the arch swings widely to the left, the origin may be from the medial wall. The angle of origin can be sharp, right, or obtuse. As the origin is always deeper than the first rib, the vessel always courses upward and to the right. According to Holzapfel, the crossing over in the midline is from C-6 to D-4."

Holzapfel (18) reviewed 134 cases of anomalous right subclavian artery and

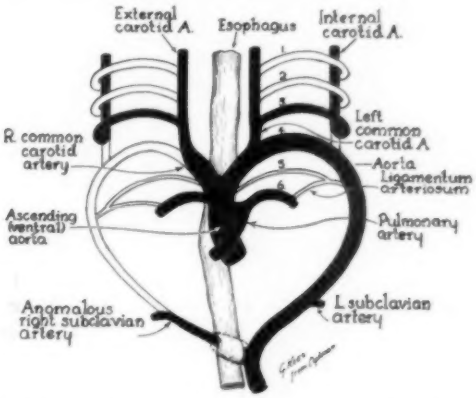

Fig. 2. Diagram of the abnormal embryological development which produces anomalous right subclavian artery (after Copleman). The right fourth arch has disappeared and the right subclavian artery develops instead from the right dorsal aortic root, arising as the last vessel from the aortic arch. The abnormal vessel may arise from an aortic diverticulum (dotted lines).

found that the vessel crossed the midline between the esophagus and spine in 80 per cent, between the esophagus and trachea in 15 per cent, and anterior to both the esophagus and trachea in 5 per cent. Several authors (6) have expressed the belief that it invariably passes behind the esophagus, but Bayford demonstrated the vessel between the esophagus and trachea at autopsy, and one of Neuhauser's cases showed the pressure defect on the anterior surface of the esophagus. No unequivocal demonstration of the anomalous vessel anterior to the trachea is recorded (6).

The branches of the anomalous subclavian artery show considerable variation, but no more so than do those of the normal subclavian artery. DeGaris (10) reported a case of extensive deep collateral circulation associated with a very small anomalous right subclavian artery. The presence or absence of a right radial pulse was not mentioned. In one of our patients (Case 1)

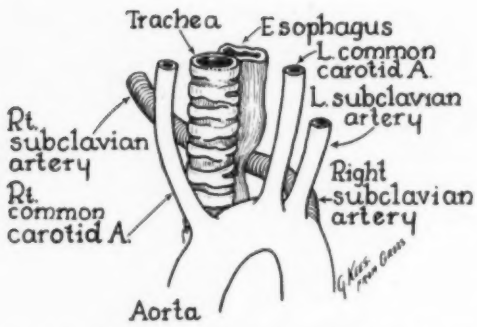

Fig. 3. Drawing showing the relationship between the aortic arch, its main branches, the esophagus, and the trachea at operation in a case of anomalous right subclavian artery (after Gross). Ventral view.

the right radial pulse is absent and there is roentgen evidence of an aortic diverticulum. We suspect that the anomalous artery in this case arises from a stenotic opening in the diverticulum.[2]

The innominate artery is usually absent. Both common carotids are said to lie closer to the midline than normal (2, 11). The thoracic duct usually terminates on the left side, as under normal conditions. The right recurrent laryngeal nerve may be completely absent (25), pass directly to the larynx from the vagus, or cross over the vertebral or inferior thyroid artery (6). In no instance does the nerve loop over the anomalous artery as it normally does (24).

CLINICAL FINDINGS

A great majority of patients with this anomaly present no related symptoms or physical findings. It is usually an incidental finding during the performance of a gastro-intestinal series or fluoroscopy of the heart. None of our 9 patients had symptoms which could be attributed to the aberrant vessel; in all it was demonstrated during barium studies which were being made for other purposes.

Occasionally symptoms or signs result from the pressure of the anomalous vessel on adjacent structures. Dysphagia is the most common symptom and is sometimes quite severe (4). It is due to compression of the upper esophagus by the artery itself or by the associated aortic diverticulum. Dysphagia may develop during childhood and later disappear (14), or it may grow progressively worse with advancing years. In infants it may be associated with regurgitation, while in adults it is occasionally accompanied by palpitation and discomfort in the upper thorax.

Significant murmurs have not been observed except when associated anomalies of the heart were present. Five of the 15 cases of aberrant right subclavian artery reported by Brean and Neuhauser (27) showed coexisting congenital heart disease. In 3 of these there was patency of the ductus arteriosus, in 1 tetralogy of Fallot, and in 1 the diagnosis was indeterminate. As stated earlier, Blalock encountered 5 cases of associated tetralogy of Fallot and anomalous subclavian artery at operation, and Humphreys 1 case. Congenital anomalies involving organs other than the heart and great vessels have occasionally been seen.

Inequality of the pulses has been recorded in a few cases, including Case 1 in our series. Trophic changes in the upper extremities have been described (17). Obstruction of the thoracic duct, erosion of dorsal vertebrae, rupture of the anomalous vessel, and fatal choking have all been reported (11, 12).

All 9 of our patients were females. In reviewing the cases in the literature, however, we found no unusual sex distribution. We have no explanation for the absence of males in the present series.

ROENTGEN FINDINGS

As stated above, the diagnosis of anomalous right subclavian artery has thus far been made only by roentgen examination. Kommerell (19), Dahm (8), and others have maintained that the condition cannot be demonstrated if the subclavian artery is normal in caliber, but Gross (13) has disproved this in each of his 5 operated cases, all discovered roentgenologically.

[2] We recently encountered at autopsy a case with a right aortic arch and an anomalous left subclavian artery arising from a stenotic opening in the base of an aortic diverticulum. This represents the mirror image of what we believe to be present in Case 1.

The reported cases have shown a striking similarity in their roentgen appearance. An abnormal imprint on the right posterolateral wall of the esophagus just above the level of the aortic knob was noted in all but one case (20). In this patient the indentation was found on the left anterior wall of the esophagus and was thought to indicate the passage of the anomalous vessel *between* the esophagus and trachea. An oblique defect crossing the esophagus and associated with an abnormal degree of pulsation of this structure has been commonly reported. Marked esophageal narrowing and even complete obstruction have occasionally been encountered (22). All of the above changes are the result of pressure by the anomalous vessel in its course behind the esophagus. An associated aortic diverticulum has been visualized in one case (23). Arendt and Wolf (3) describe a disturbance in the swallowing act, with retention of barium in the valleculae and pyriform sinuses (the "vallecular sign") in their case. Erosion of a dorsal vertebra has been observed in an anatomic specimen (11) but has not as yet been demonstrated roentgenologically. The aortic knob appeared smaller than normal in one case (19). So far as we know, the demonstration of an anomalous right subclavian artery by angiocardiography has not been attempted.[3]

The following roentgen changes were encountered in the 9 cases which we have studied:

1. In all cases an abnormal imprint was seen on the right posterolateral wall of the barium-filled esophagus at the level of the body of the third or fourth dorsal vertebra, usually best demonstrated in the lateral view (Fig. 5). It was located just above and opposite the aortic imprint. The indentation was either notched or semicircular and varied from 0.5 to 2.0 cm. in length. A large imprint is said to favor the presence of an associated aortic diverticulum.

[3] By means of catheter arteriography we successfully ruled out the presence of an anomalous subclavian artery in a recent case (28).

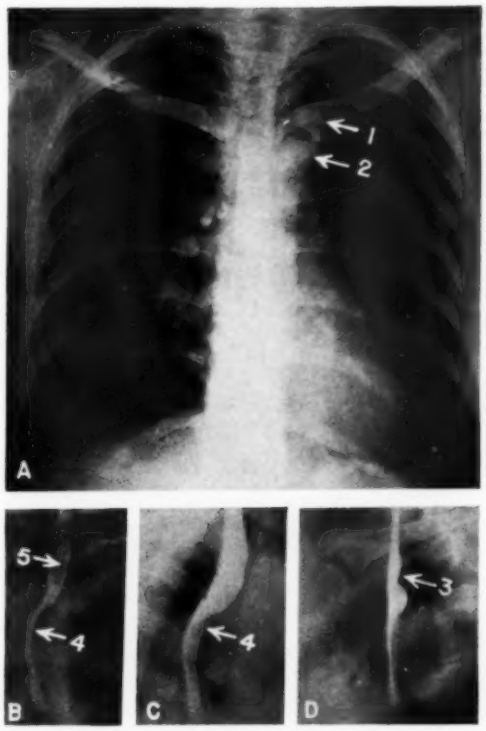

Fig. 4. Case 1. Anomalous right subclavian artery with aortic diverticulum. White female, age 19. Clinical diagnosis: Neurasthenia. Right radial pulse absent. Blood pressure in right arm 106/80; in left arm 120/72. Soft short systolic murmur heard best over pulmonic area. No symptoms referable to the anomalous vessel.

A. Postero-anterior view of chest. B. Postero-anterior spot film. C. Right anterior oblique. D. Left anterior oblique.

1. Aortic diverticulum. 2. Aortic knob. 3. Notch on posterior aspect of esophagus. 4. Aortic imprint. 5. Linear defect in esophagus.

2. An oblique ridge-like filling defect traversing the barium-filled esophagus was visualized in 4 cases (Figs. 5, 7, and 8). This defect, varying from 0.5 to 1.5 cm. in width, passed upward from left to right, from the upper border of the aortic imprint to the marginal indentation described above. The defect was best seen in the postero-anterior and left oblique views, especially when a small quantity of barium was given. With larger amounts of barium it was partially or completely obscured.

3. Localized transmitted pulsations of the esophagus were seen in the region of the defect in 8 of the 9 patients. These pulsa-

Fig. 5. Case 2. White female, age 22. Clinical diagnosis: Malignant hypertension. Blood pressure 190/135 in both arms. No symptoms related to the anomalous vessel.
A. Postero-anterior view. B. Right anterior oblique. C. Left anterior oblique. D. Lateral.
1. Aortic imprint. 2. Linear defect in esophagus. 3. Large right posterior defect in esophagus caused by the anomalous vessel. The size of this defect suggests the presence of an associated aortic diverticulum.

tions were quite striking fluoroscopically and occurred synchronously with the aortic pulsations. Stauffer and Pote were unable to demonstrate this finding in their patient.

4. Narrowing of the esophagus at the level of the anomalous artery was observed in 4 cases but was usually mild in degree. It was demonstrated most clearly in the oblique views. In one case (Fig. 5) there was delay in the passage of barium through the area of narrowing, but this was not associated with symptoms. Complete obstruction to the opaque meal was not encountered.

5. An aortic diverticulum was directly visualized in only one case in our series. It was best seen in the postero-anterior view as a prominence to the left of the spine, immediately above and almost continuous with the aortic knob (Fig. 4). At first glance this prominence appeared to represent the aortic knob itself, but on more careful study the latter and its imprint on the esophagus could be made out caudalward. On fluoroscopy the aortic knob and diverticulum pulsated simultaneously. The aortic knob in this, as in all our other cases, was approximately normal in size.

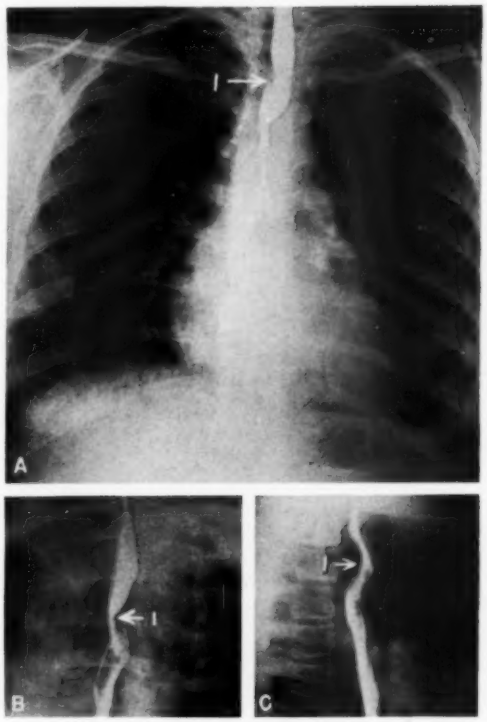

Fig. 6. Case 3. White female, age 13. Clinical diagnosis: Rheumatic heart disease. Blood pressure 110/76 in both arms. No symptoms related to the anomalous artery.
A. Postero-anterior view. B. Left anterior oblique. C. Lateral.
1. Small right posterior defect in esophagus caused by the anomalous subclavian artery.

DIFFERENTIAL DIAGNOSIS

A right aortic arch produces an indentation on the right side of the barium-filled esophagus similar to that produced by the anomalous right subclavian artery, but usually larger. Absence of a normal aortic knob and imprint on the left side establishes the diagnosis of right aortic arch.

With a double aortic arch bilateral indentations on the esophagus are seen in the postero-anterior view. The two defects occur at the same level, the larger one usually being on the right side. With aberrant right subclavian artery the smaller defect occurs on the right and lies cephalad to the left-sided aortic knob and imprint.

The anomalous vessel can readily be differentiated from such conditions as enlarged mediastinal lymph nodes, intramural tumor of the esophagus, aneurysm, etc., by the characteristic location, size, and appearance of its esophageal defect. The presence of forceful pulsations in the region of the defect favors a vascular abnormality.

DISCUSSION

In few of the cases reported in the literature and in none in our series has the roentgen diagnosis been confirmed at operation or necropsy. Nevertheless, it is felt that the changes are sufficiently characteristic to leave little doubt concerning their authenticity. Furthermore, employment of similar roentgen criteria led to the correct preoperative diagnosis in the 5 cases operated upon by Gross.

The importance of routine examination of the entire esophagus during gastrointestinal studies should be stressed. The demonstration of a defect on the posterior

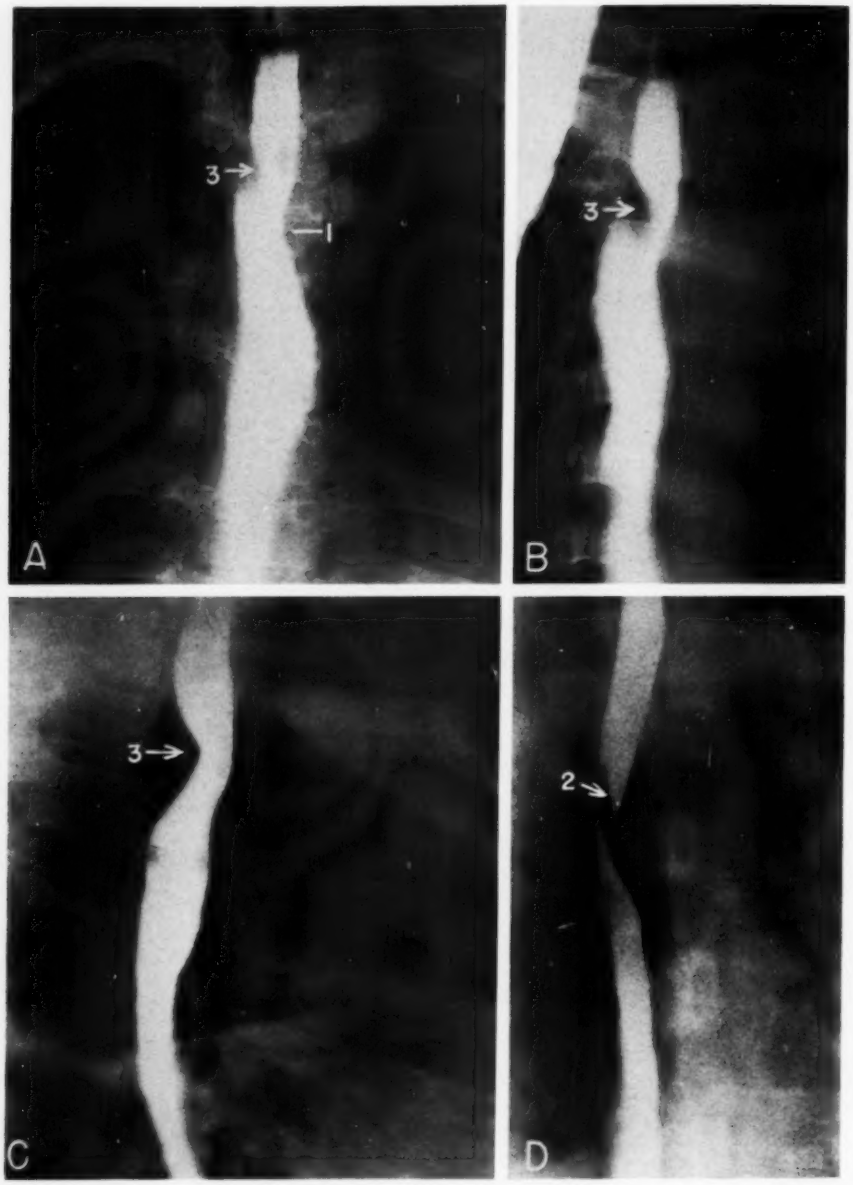

Fig. 7. Case 4. Colored female, age 43. Clinical diagnosis: Essential hypertension. Blood pressure 200/110 in both arms. Loud harsh systolic murmur over aortic area.
A. Postero-anterior view. B. Right anterior oblique. C. Lateral. D. Left anterior oblique. 1. Aortic imprint. 2. Linear defect in esophagus. 3. Right posterolateral notching of esophagus.

aspect of the upper esophagus usually signifies an anomaly of one of the great vessels and is an indication for further study to determine its identity and importance. It should be further emphasized that these anomalies are not rare and that they may cause severe and even fatal symptoms. Their recognition in such cases

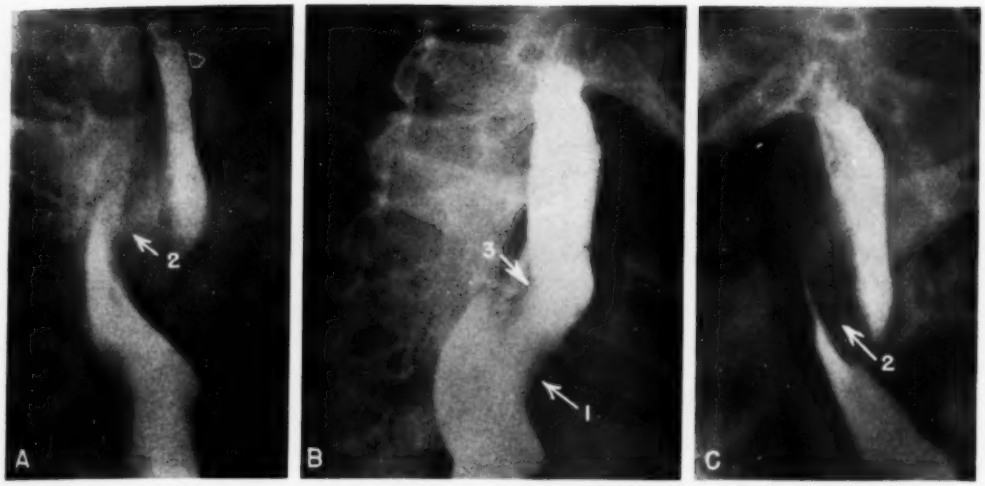

Fig. 8. Case 5. Colored female, age 51. Clinical diagnosis: Hypertensive heart disease with failure Blood pressure 210/110 in both arms. No symptoms related to the anomalous vessel. Death (no autopsy).
A. Postero-anterior view. B. Right anterior oblique. C. Left anterior oblique.
1. Aortic imprint. 2. Large linear defect in esophagus. 3. Notch in right posterior wall of esophagus.

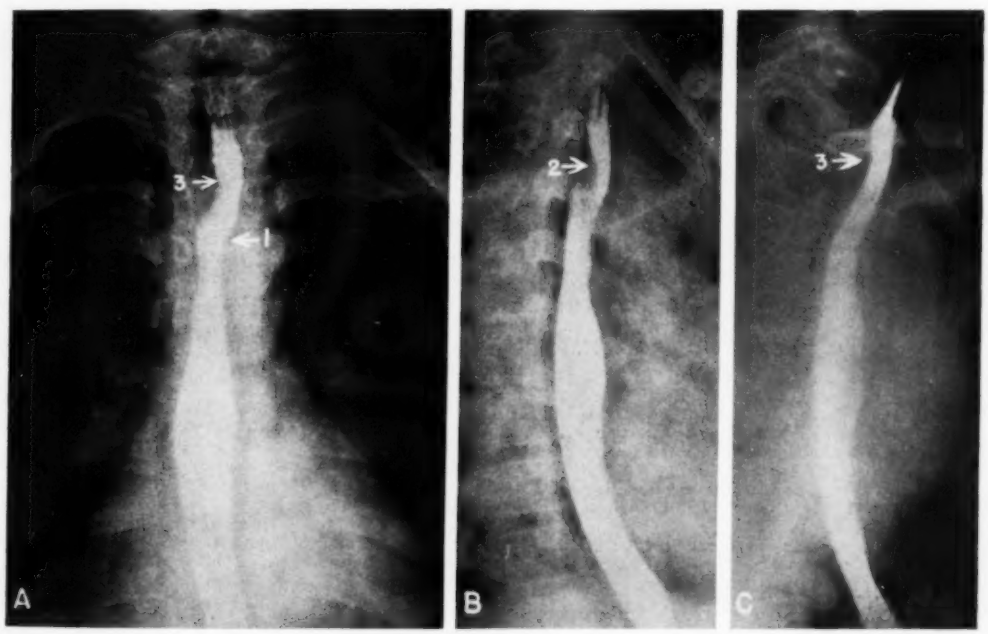

Fig. 9. Case 6 (courtesy of Children's Hospital). White female, age 8. Clinical diagnosis: Acute rheumatic fever. Blood pressure 90/60 in both arms. Soft systolic murmur at apex.
A. Postero-anterior view. B. Right anterior oblique. C. Lateral.
1. Aortic imprint. 2. Linear defect in esophagus. 3. Right posterolateral defect in esophagus.

provides the opportunity for a surgical cure.

SUMMARY

1. A series of 9 cases of anomalous right subclavian artery is reported, and the roentgen findings in 6 are illustrated.

2. The anomalous origin of the right subclavian artery as the last vessel from the aortic arch is of relatively common occurrence but has seldom been diagnosed during life. It is usually asymptomatic but on occasion it may give rise to severe and even fatal symptoms.

3. The anomalous vessel usually crosses the spine behind the esophagus.

4. The diagnosis can readily be made roentgenologically by the demonstration of a characteristic imprint on the barium-filled esophagus just above and opposite the aortic imprint, an oblique filling defect in the esophagus at this level, and an abnormal esophageal pulsation in the region of the defect.

5. The recognition of the anomaly may provide the explanation for symptoms in some cases, and facilitate surgical cure. Successful ligation of the anomalous vessel has been accomplished by Gross in 5 symptomatic cases, resulting in complete cure.

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SUMARIO

Arteria Subclavia Derecha Anómala

La serie comunicada comprende 9 casos de arteria subclavia derecha anómala, con los hallazgos roentgenológicos en 6 de ellos. El origen anómalo de la arteria subclavia derecha como último vaso que parte del cayado de la aorta es relativamente común,

pero rara vez diagnosticado durante la vida. Suele ser asintomático, pero a veces puede ocasionar síntomas graves y hasta letales.

El vaso anómalo suele cruzar la espina dorsal detrás del esófago.

El diagnóstico puede hacerse con facilidad roentgenológicamente al observar una típica huella en el esófago lleno de bario precisamente más arriba y enfrente de la huella aórtica, un nicho oblicuo en el esófago a dicho nivel y una pulsación esofágica anormal en la región del nicho.

El reconocimiento de la anomalía puede suministrar la explicación de los síntomas en algunos casos, y facilitar la curación quirúrgica. La ligadura del vaso anómalo ha sido realizada con éxito por Gross en 5 casos sintomáticos, logrando la curación completa.

Pigmented Villonodular Synovitis[1]

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THE LITERATURE is replete with reports of what we believe to be a single lesion of the synovial membrane described under various titles. Among these are giant-cell tumor of the synovia, xanthoma, hemorrhagic villous synovitis, sclerosing hemangioma, xanthogranuloma, pigmented giant-cell xanthosarcoma, benign synovioma, and pigmented villonodular synovitis. This host of terms may be explained to some extent by the varied histologic picture and the greater or less import ascribed to the different cellular components by the individual pathologist.

In 1941, Jaffe, Lichtenstein, and Sutro (1), after exploring various stages in the life history of this synovial lesion, suggested the term "pigmented villonodular synovitis." They described also its anatomical equivalent involving tendon sheaths and bursae. Microscopic findings in both early and late phases of the disease were critically analyzed, and the common origin of the cellular components from primitive connective-tissue cells of the lining synovia was noted. Evidence was presented to show that the previous conception of the lesion as a neoplasm was unsound, and that the evolution, as well as the histologic findings, indicate that the process is entirely inflammatory. With the publication of this significant article, a splendid contribution was made toward the clarification of the disease process.

In spite of the report of Jaffe and his associates, one finds that a uniform nomenclature has still to be accepted and that considerable difference of opinion exists among those concerned with the diagnosis and classification of villonodular synovitis. It is surprising, furthermore, to see how few reports have appeared in the radiologic literature.

Not only is the nomenclature confusing, but the management of this lesion has also been subject to considerable variation. Kling and Sashin (2) recommended either total synovectomy or partial synovectomy with postoperative roentgen therapy. Galloway *et al.* (3), dealing with 70 cases, advised conservative surgical treatment and questioned the value of irradiation on the basis of a small number of cases so treated. De Santo and Wilson (4), analyzing 41 cases, found recurrence in 7 of the 32 patients followed. They concluded: "The proper treatment is radical extirpation. It is possible that postoperative radiation may be of some value in preventing local recurrence, but its use in large doses as the primary method of treatment would almost certainly result in loss of joint function and would offer little hope of causing disappearance of the tumor."

The first report on roentgen therapy as the treatment of choice in the management of this lesion was that of Friedman and Ginzler (5), appearing in 1940. Under the title "Xanthogranuloma of the Knee Joint," the authors presented 2 histologically confirmed cases which were treated with fractionated high-voltage x-ray therapy in moderate dosage. In both instances there were disappearance of the associated effusion, reduction of pain, and return of normal joint function. Lewis (6), in a later report, well illustrated, described 4 cases in which roentgen therapy and/or synovectomy were employed and concluded that "there is some evidence that roentgen therapy influences pigmented villonodular synovitis favorably."

The purpose of the present paper is to review briefly the clinical course and histology of this lesion and to report our preliminary experience in its diagnosis and

[1] From the Radiation Therapy Section, Walter Reed General Hospital, Washington 12, D. C. Accepted for publication in January 1949.

management on the basis of 5 cases. In one of these cases there was histologic confirmation of involvement of more than one joint, a feature of unusual interest in light of the observation by Lichtenstein, Jaffe, and Sutro (1) that "the lesion seems always to be monarticular."

Pigmented villonodular synovitis is found most frequently in young adults, who give a history of monarticular joint swelling of months or years duration, unassociated with fever or local signs of inflammation. A slight to moderate degree of pain may be present, as well as some limitation of motion or stiffness. Examination shows effusion (diminished by rest and immobilization) out of all proportion to the patient's complaints. The usual area of involvement is the knee joint, and palpable nodules may be present in the suprapatellar, infrapatellar, or popliteal spaces. These are found most commonly in the late stages of the disease, or may become apparent following aspiration of the joint. There are stiffness and inability either to fully flex or extend the joint. Fluid aspirated from the synovial space is amber or xanthochromic, with all the physical characteristics of a transudate; it reaccumulates rapidly following aspiration, and the relief is only temporary.

The diagnosis of villonodular synovitis rests mainly on clinical grounds supported by surgical confirmation rather than upon the radiologic findings, which are usually contributory in only a negative sense. There is soft-tissue swelling in the region of the involved synovia. The absence of osseous changes serves to differentiate the lesion from other diseases of bone and joints. Nodular increase in density is revealed by soft-tissue technics in the region of the synovia. Pneumography in 3 of our 5 cases failed to show evidence of synovial disease. The pathologic diagnosis depends upon the stage of the disease in which the synovia is explored and the predominant cellular component. We believe further that the response or lack of response to roentgen therapy may be correlated with the stage of the disease.

Examination of the early lesion reveals synovial-lined villi with a vascularized stroma. The vascular component may predominate to such an extent that the diagnosis of sclerosing hemangioma is suggested. Many small vessels are seen, and frequently considerable blood pigment in the form of hemosiderin, both intracellular and extracellular. Inflammatory components, including small lymphocytes, occasional plasma cells, and macrophages are found. Foreign-body giant cells are rare or entirely absent. Large histiocytes or mononuclear cells, whose cytoplasm is vacuolated and foamy, are interspersed in the stromal network.

In this phase of the disease, response to roentgen therapy will be rapid. The histologic components are chiefly radiosensitive elements and the vascularized stroma contributes secondarily to the radiotherapeutic response. The lesion has all the appearance of an inflammatory process, both histologically and in its response to high-voltage x-ray therapy in moderate dosage. Roentgen irradiation would, in fact, be the logical method of attack following histologic confirmation of the diagnosis.

In synovitis of long standing, the microscopic findings are markedly altered. The villous character of the synovia may be absent. Focal areas of pigmentation in the form of hemosiderin are found scattered throughout the stroma, which is chiefly fibrous. In the most advanced phases, considerable hyalinization and sclerosis of the stromal tissue are present. In conjunction with focal areas of chronic inflammation, numerous giant cells are seen, and their presence has confused the histologic picture, resulting in a diagnosis of giant-cell tumor.

Response to radiation in the late stage is slow but definite. This is particularly true in cases in which sclerosing and hyalinized fibrous tissue predominates. The absence of a vascularized stroma necessitates the administration of larger doses of high-voltage radiation, but even in the advanced phase, should the inflammatory

Fig. 1. Case 1: Nodular densities in the synovial space without bone involvement, characteristic of pigmented villonodular synovitis.

Fig. 2. Case 1: Section (× *c.90*) showing highly vascularized granulation tissue with scattered inflammatory cells.

component predominate, one may still expect a good response.

Histologically, our 5 cases represent various phases of the life history of the process. The disease was confined to the knee joint in 4 cases and to the ankle in the fifth. The lesions were monarticular except in Case 3, in which both knee joints were involved. In only 1 case could a definite history of trauma be obtained. Two cases were treated by partial synovectomy, with postoperative irradiation for residual disease. The remaining 3 patients received roentgen therapy exclusively, in moderate dosage.

CASE REPORTS

CASE 1: A 25-year-old white officer was well until July 1944, when he received a severe contusion of his right knee in an airplane accident. One month later he noticed painless swelling about the joint. He wore an elastic bandage for support, but the swelling failed to subside, and in October 1944 the knee became painful. Ten months following the onset of symptoms, examination showed atrophy of the right quadriceps and moderate effusion in the right knee. During the next three months the joint was repeatedly aspirated, with removal of 20 to 100 c.c. of bloody fluid. Repeated radiographic studies showed only nodular soft-tissue swelling, without osseous involvement (Fig. 1).

On Oct. 25, 1945, an exploratory arthrotomy was performed. Old blood was found in the synovial capsule, and the synovium of the suprapatellar pouch was thickened and hemorrhagic. The articular cartilage of the patella was yellowish and fissured. A partial synovectomy was done, and a histologic diagnosis of "giant-cell tumor of the synovia" was made. The patient was transferred to Walter Reed General Hospital for further study and treatment.

On admission, the right knee was markedly swollen, chiefly in the suprapatellar and infrapatellar pouches. Posteriorly in the popliteal space were two fixed, firm nodules, medial to the hamstring tendon about 1.5 to 2 cm. in diameter. Motion was re-

Fig. 3. Case 2: Nodular mass showing erosion of adjacent tibia.

stricted to 75 per cent normal extension and 50 per cent normal flexion. It was necessary for the patient to use a crutch to walk because of the associated discomfort. Blood studies were essentially normal.

The sections were reviewed and the following report was made: "Section (Fig. 2) consists of a dense infiltration of lymphocytes, plasma cells, and histiocytes, a few of the latter having a somewhat foamy cytoplasm. Throughout there are dense trabeculating zones of fibrous tissue and occasional aggregates of giant cells which contain from 5 to 30 or more centrally placed nuclei. There are occasional areas of phagocytized blood pigment, some of which lies extracellular. *Diagnosis:* Granulomatous process involving the synovia."

Because of the residual disease and the recognition of this process as a variant of villonodular synovitis, roentgen therapy was advised. From Dec. 12, 1945, to Jan. 4, 1946, the patient received 2,400 r, measured in air with back-scatter, to both the anterior and posterior aspects of the right knee, through portals measuring 10 × 20 cm. Physical factors were as follows: 200 kv., 20 ma., 50 cm. target-skin distance, 0.5 mm. Cu plus 1.0 mm. Al filtration, half-value layer 0.9 mm. Cu, 38 r per minute, in air. (The same factors were used in the treatment of all the cases to follow).

The swelling of the right knee subsided slowly, but at the completion of this course of treatment, the nodules in the popliteal region had shrunk to half their initial size. The patient was able to walk without a crutch and resumed a moderate amount of activity. Motion and flexion still remained impaired to about 75 per cent of normal. During the next several months, further shrinkage took place, but there were still residual swelling of the knee joint, slight discomfort on motion, and impaired mobility in flexion. Consequently, a second course of x-ray therapy was given from May 20 to June 3, 1946, delivering 1,500 r (in air with back-scatter) each to the anterior and posterior aspects of the knee. Three months later the swelling had completely disappeared but there were still some stiffness of the knee joint and limitation of motion. Clinical improvement, however, was satisfactory, and the patient was able to resume normal activity. In February 1947, when he was last seen, there was no soft-tissue swelling about the knee and slightly less stiffness than at the previous examination.

CASE 2: A 28-year-old white female was admitted to Walter Reed General Hospital, complaining of swelling of the right ankle of some eleven years duration, unassociated with trauma. The joint was painless until June 1947, when the patient began to complain of paresthesia. The swelling became progressively larger and on admission formed a nodular mass, 3 cm. in diameter, over the lateral aspect of the ankle. There was no evidence of discoloration.

A clinical diagnosis of ganglion was made, and on July 15, 1947, the patient was hospitalized. Radiographic studies of the right ankle revealed a soft-tissue mass overlying the lateral aspect of the right fibula (Fig. 3). Laboratory studies, including serum calcium, phosphorus, and cholesterol, were normal. Hemogram, sedimentation rate, and the Kahn serologic test were negative.

On July 17, operation was done. What appeared to be a well encapsulated tumor, measuring 3.0 × 1.5 cm., friable, and light bluish in color, was found in the region of the tibiofibular joint. There was an area of bone erosion on the tibia as a result of extrinsic pressure from this tumor. The synovial capsule was opened and was described as normal.

The pathologic report was as follows: "The specimen consists of a firm disk-shaped nodule measuring 2.5 cm. in diameter and 0.5 cm. in thickness, surrounded by dense, fibrofatty tissue. On section, it is composed of firm, white, smooth tissue, with softer interspersed areas of yellow mottling. There are also definite discrete nodules within the tumor measuring up to 4 mm. in diameter and demarcated by a thin, brown capsule. Sections show some areas

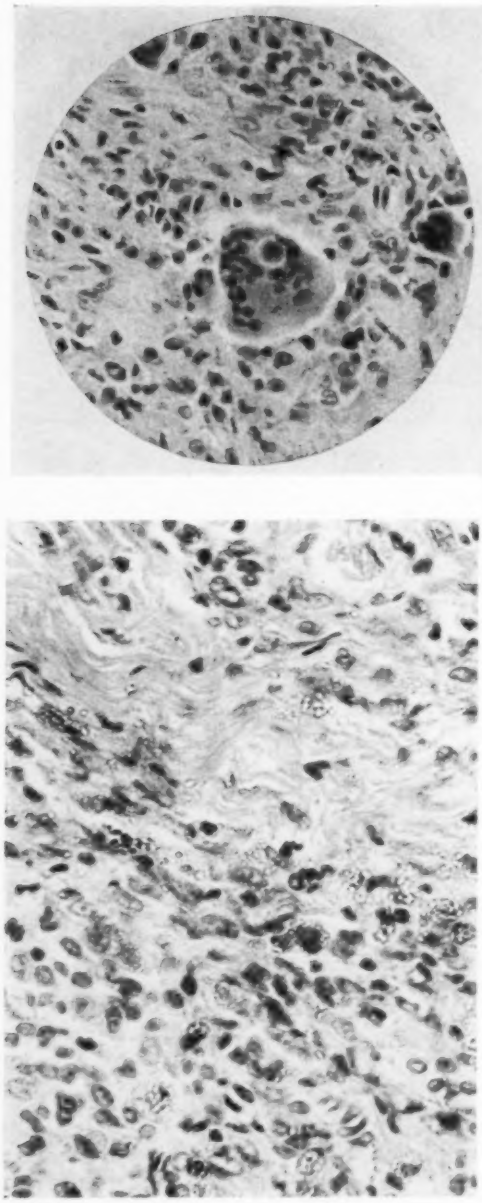

Fig. 4. Case 2: Sections showing typical giant cell, fibrous stroma, and much extracellular pigment.

of highly cellular foci of spindle and ovoid uniformly compressed cells lying in a dense fibrillar substance, tending to form poorly defined interlacing sheets. Throughout these cellular areas are scattered numerous multinucleated giant cells exhibiting 10 to 20 nuclei which tend to be centrally placed. In other areas cellularity is sparse. The ground substance is more or less homogeneous and in many areas hyalinized. About the periphery of the nodules, occasional lymph follicles are seen and the cells are compressed, forming a pseudocapsule. Throughout the sections, thickened and hyalinized large vessels are seen and numerous foci of hemosiderin deposits are noted. Along one section is a single layer of pavement cells resembling mesothelium. *Diagnosis:* Giant-cell tumor of synovial membrane, benign."

Postoperatively, for several weeks, there was diffuse residual swelling over the anterolateral aspect of the ankle joint. Because of the difficulty of complete removal of the lesion and its known tendency to recur, postoperative roentgen therapy was advised. From Sept. 4, 1947, to Sept. 17, 1947, 1,500 r (measured in air with back-scatter) was delivered to both the medial and lateral aspects of the ankle joint. Within two weeks following the completion of therapy, the swelling had almost completely disappeared. The patient has since been seen on several occasions. On the last of these, June 1, 1948, examination showed no recurrence of disease, and restoration of function was complete.

Review of the history, operative findings, and the microscopic study (Fig. 4) support our opinion that this is also a case of villonodular synovitis. The histologic findings suggest that it was an advanced phase with a predominance of giant cells and hyalinized stroma. The exact location of the lesion as to involvement of synovia or tendon sheath is not clear, since, upon opening the synovia, it was said to be normal.

CASE 3: A 24-year-old white soldier was referred to the Radiation Therapy Section for consultation in July 1947, because of stiffness and swelling of both knees. The patient had been well until August 1946, when mild swelling of both knees developed. This was unassociated with any known trauma. Shortly therafter the knee joints became painful.

In May 1947, the patient was admitted to Tilton General Hospital. Both knee joints were aspirated and approximately 80 to 90 c.c. of viscous amber fluid was removed from each. The fluid had a specific gravity of 1.020, and both smears and cultures, including guinea-pig inoculation, were negative.

As the patient failed to improve, exploratory arthrotomy was performed on the left knee on May 22, 1947, at which time 60 c.c. of amber fluid was removed. The synovial membrane was nodular, thickened, and hemorrhagic, and a portion was removed for study.

The pathologic report was as follows: "There is marked thickening of the synovial membrane. The mucosa, composed of hyperplastic cuboidal and in some areas pseudostratified columnar epithelium, is arranged in irregular villous projections formed by

granulation tissue. This tissue has a loose fibrous structure and within meshes there are accumulations of lymphocytes, plasma cells, and occasional large mononuclear cells containing hemosiderin pigment. *Diagnosis:* Pigmented villonodular synovitis of knee joint."

The patient was transferred to Walter Reed General Hospital for further disposition. Examination showed marked swelling of both knees, out of proportion to the pain or limitation of motion. There was 25 per cent limitation of motion in extension of the knee joints. Bilateral pneumoarthrograms, following removal of 150 c.c. and 70 c.c. of gelatinous amber fluid from the left and right knee respectively, were essentially normal.

Though a microscopic diagnosis of villonodular synovitis was made on tissue from the left knee joint, it was considered advisable to explore the right knee because of the rarity of bilateral involvement in this condition. Therefore, on Aug. 8, 1947, an arthrotomy was done on the right knee. There was considerable thickening of the synovia in the region of the prepatellar fat pad.

Examination of a biopsy specimen revealed small papillomatous growths whose surface was covered by a single layer of columnar to cuboidal epithelium. The growths contained a vascular stroma showing a marked round-cell and plasma-cell infiltration, as well as slight endothelial and perivascular thickening. There was only an occasional macrophage present filled with pigment. *Diagnosis:* Synovitis, chronic villous.

Roentgen therapy was advised, and during the next month the patient received a dose of 1,800 r (measured in air with backscatter) through 10 × 15-cm. portals, anteriorly and posteriorly to each knee joint. At the completion of treatment, the swelling in the left knee was reduced by 60 per cent. The right knee showed no significant change. The patient was observed for about two months, during which time further improvement occurred. There was still residual swelling of about 30 per cent, and a second course of irradiation was given from Nov. 3 to Nov. 21, 1947, delivering 1,200 r to each knee joint anteriorly and posteriorly.

Further improvement followed, and in March 1948, the knees were normal in appearance. There was slight pain on complete flexion, but the patient is capable of carrying on completely normal activity.

CASE 4: A 20-year-old white soldier was well until August 1946, when he experienced painful swelling of the right knee. There was no history of injury, but the swelling and discomfort were aggravated by walking and marching. In December 1946, he was admitted to Oliver General Hospital for treatment. He received diathermy and bed rest, with moderate improvement and was discharged and returned to active duty. The pain and swelling in the right knee recurred, however, and the patient was subsequently admitted to Walter Reed General Hospital for study.

Examination on admission showed a swollen right knee which was tender to palpation. The joint was not warm, and the skin about it showed no redness. There was no limitation in flexion, but approximately 10 degrees limitation in extension.

Laboratory studies showed a normal blood count. Agglutination studies for undulant fever were negative. Blood chemistry studies, including calcium, phosphorus, and cholesterol, were normal. Fluid aspirated from the joint was xanthochromic and contained 4 per cent protein; cultures showed no growth.

Radiographic studies of the right knee, including a pneumoarthrogram, revealed only a diffuse soft-tissue swelling about the knee joint.

On Sept. 2, 1947, exploratory arthrotomy was done. Upon opening the joint capsule, a moderate amount of xanthochromic fluid was encountered. The synovial membrane showed a diffuse nodular thickening with brownish discoloration over its entire surface. A biopsy was done.

The pathologic report was as follows: "Examination reveals several large pieces of fibrous tissue whose surface is covered generally by a single layer of cuboidal cells. The surface is irregular, with frequent papillary projections throughout the tissue, but particularly immediately beneath the synovial membrane. One focus shows an area of old hemorrhage, surrounding which there are numerous golden-yellow pigment-laden histiocytes. *Diagnosis:* Chronic synovitis."

X-ray therapy was begun on Sept. 19, 1,500 r with back-scatter being given to the anterior and posterior aspects of the right knee through 10 × 15-cm. portals in a period of two weeks. One month following completion of treatment, there was marked reduction in the swelling and no complaint of pain. The patient was last seen in March 1948, when he was carrying on normal activity without restriction. The right knee joint appeared entirely normal, and there was no limitation of motion.

CASE 5: A 33-year-old white soldier complained of pain and slight swelling in the left popliteal fossa early in October 1947. The swelling increased moderately, and in November 1947 he was admitted to Walter Reed General Hospital. No history of trauma was obtained.

Examination of the left knee showed swelling most marked in the popliteal fossa. There was no redness or increased skin temperature over this area. The knee was maintained in slight flexion, and any motion was painful.

Radiographic studies were essentially negative. Pneumoarthrograms were done following aspiration of 60 c.c. of dark green fluid from the posterior synovial space, but were non-contributory.

Laboratory study of the fluid was negative for organisms. The cell count was 475 with 93 per cent lymphocytes. Blood chemistry, including serum calcium, phosphorus, acid and alkaline phosphatase determinations, was normal.

The clinical impression was that of popliteal cyst. On Jan. 8, 1948, exploratory arthrotomy was done, revealing the entire synovial membrane studded with nodular implants about 2 to 10 mm. in diameter. The surface of the membrane showed a yellowish-brown discoloration. Biopsy was done and reported as nodular synovitis.

Postoperatively, the patient was given radiation therapy. From Feb. 2 to Feb. 17, 1948, he received a dose of 1500 r (with back-scatter) to the left knee through anterior and posterior portals. During the next month, improvement was slow but definite. Complete extension became possible and the swelling completely disappeared. Joint function was good, and the patient returned to normal activity without restriction.

SUMMARY

1. The literature dealing with pigmented villonodular synovitis and its related variants has been briefly reviewed.

2. The gross and microscopic findings in the various phases of the life history of the disease have been noted and correlated with possible radiotherapeutic response.

3. Histories are presented in 5 histologically confirmed cases, illustrating the clinical findings, diagnosis, and method of treatment.

4. Our experience indicates that roentgen therapy is the treatment of choice following exploratory arthrotomy and biopsy of pigmented villonodular synovitis. Five cases were treated with roentgen therapy either following partial synovectomy or biopsy with favorable response in all. Microscopic findings in two of the cases are illustrated to support the use of properly administered roentgen therapy on histologic grounds.

NOTE: The authors wish to express their appreciation to Miss Phyllis Anderson for the excellent drawings used in this article, and to the Photographic Section, Laboratory Service of Walter Reed General Hospital.

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SUMARIO

Sinovitis Pilonodular Pigmentada

Después de repasar la evolución clínica y la histología de la sinovitis vellonodular pigmentada, los AA. comunican sus observaciones preliminares en el diagnóstico y el tratamiento del estado en cinco casos.

El diagnóstico asiéntase principalmente en datos clínicos apoyados por la confirmación quirúrgica, más bien que en los hallazgos radiológicos, aunque la ausencia de patología ósea sirve para diferenciar la lesión de otras afecciones de los huesos y articulaciones. Los hallazgos patológicos dependen del período de la enfermedad en que se explora la sinovia y del predominante componente celular. La respuesta a la roentgenoterapia también se correlaciona con el período del proceso. En las lesiones tempranas la respuesta a la irradiación es rápida. En los casos muy antiguos la respuesta es lenta, pero bien definida, sobre todo cuando predomina el tejido fibroso esclerosante e hialinizado. La ausencia de estroma vascularizado exige mayores dosis de radiaciones de alto voltaje, pero aun en la fase avanzada cabe esperar una buena respuesta, con tal que predomine el componente inflamatorio.

Los cinco enfermos de los AA. recibieron la roentgenoterapia (200 kv., 20 ma., 50 cm. distancia foco-piel, filtración por 0.5 mm. de Cu más 1.0 mm. de Al, c. de hemirred 0.9 mm. Cu) después de la sinovectomía parcial o la biopsia, siendo la respuesta favorable en todos.

An Unusual Lesion of the Talus Occurring in Leprosy[1]

PAUL T. ERICKSON M.D.,[2] and A. MAYORAL, M.D., F.A.C.R.[3]

AN UNUSUAL destructive lesion of the talus, considered to be of leprous origin, was recently observed in two patients at the National Leprosarium, Carville, La. (1). Both had lepromatous leprosy of several years duration. Secondary neural manifestations were minimal, and no coexistent disease was present. The clinical circumstances under which the lesion developed, its roentgen appearance, and its tendency toward regeneration suggest an infectious origin rather than the neurotrophic absorptive phenomenon seen so commonly in the more peripheral bones of the hands and feet in leprosy.

Clinically, the lesion was of insidious onset, manifesting itself during prolonged lepra reactions by intermittent pain and swelling in the ankle region. Roentgenologically, bone changes in the early stages were difficult to detect, and not until the pain and swelling became persistent was the destructive process demonstrable. It consisted of a small area of decreased density, of moth-eaten appearance, in the inferior portion of the neck and head of the talus. The lesion gradually increased in size over a period of several weeks until the entire neck and head of the bone were involved. In one patient the lesion did not extend further; in the other, presumably because of premature weight-bearing, the destructive process continued through the articulating cartilage into the talocalcaneonavicular articulation. In this latter instance, a deformity resulted similar to that seen in fracture of the neck of the talus—a splay foot with flattening of the longitudinal arch and abduction of the anterior part of the foot at the mid-tarsal joint. Suppuration, as far as could be determined, was absent and a tendency toward regeneration or healing of the lesion was observed. The roentgenogram made after healing showed a distinctive picture consisting of absence of the head and neck of the talus with a whorl of callus projecting upward from the distal end of the bone.

At no time prior to the onset of the condition, nor during its onset or course, was there any evidence of ulceration or of a nonspecific infection of the overlying skin and soft tissue. The lesion could not, therefore, be attributed to extension of a superficial infection to the underlying bone. Neither was there any extensive neurotrophic disturbance present, as evidenced by absence of trophic ulceration, muscular atrophy, and advanced bone absorption, although a stocking-like anesthesia of the skin was detected over the feet and lower portion of the legs.

CASE REPORTS

Case 1: A white female, aged 34, with far advanced mixed leprosy, predominantly lepromatous, of fourteen years duration began having a prolonged series of lepra reactions in the early part of 1946. These required several periods of hospitalization and were characterized by a diurnal temperature reaching 38.4° C., swelling of the face and extremities, erythema nodosum, and neuritis. On Dec. 18, 1946, the patient was hospitalized because of pain, stiffness, and swelling of the right ankle. Roentgen examination revealed a very small area of questionable decreased density in the inferior portion of the neck of the talus. This was not considered to be significant at that time and when, after a few days, the acute symptoms subsided, the patient was allowed to leave the infirmary. Except for intermittent pain in the ankle, which it was felt was due to leprous neuritis, there was no indication of any severe bone involvement until June 1947.

On June 11, the patient was again hospitalized, complaining of seve repain in the right ankle with stiffness and marked swelling slightly below the level of the ankle joint. Roentgen examination at this time revealed an area of definite decreased density, of moth-eaten appearance, in the inferior portion of the neck and head of the talus (Fig. 1).

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Fig. 1. Case 1. Roentgenogram of right foot, taken June 11, 1947, showing beginning of lesion as an area of decreased density in the inferior portion of the neck and head of the talus.

Fig. 2. Case 1. Roentgenogram of right foot, taken Aug. 29, 1947, showing lesion at its height as an area of decreased density of moth-eaten appearance involving the entire neck and head of the talus, with shortening of the bone. Note absence of involvement of articular cartilage.

Subsequent examinations showed a gradual extension of this area until, on Aug. 29, the seventy-ninth day after hospitalization, the loss of bone substance was found to involve the entire neck and head of the talus. The destructive process did not go beyond the bony part of the talus, terminating abruptly at the articular cartilages (Fig. 2).

The patient showed clinical and symptomatic improvement after bed rest and definite roentgen evidence of some healing was observed on Oct. 21 (Fig. 3). Physiotherapy in the form of heat, massage, and passive exercises were employed, but weight-bearing was not resumed until March 11, 1948. Only slight evidence of flattening of the longitudinal arch and very little, if any, permanent limitation of motion resulted. A roentgenogram at that time showed shortening of the talus with a whorl of callus at the superior portion of its distal end, the articulating cartilages being free from involvement (Fig. 4).

At no time during the course of the condition was there any evidence of ulceration or break in the overlying skin nor was any associated or intercurrent general infectious disease present.

Case 2: A white female, aged 41, with moderately advanced mixed leprosy, predominantly lepromatous, of seven years duration had an acute lepra reaction beginning Feb. 8, 1947. This was characterized by a diurnal temperature reaching 38.0° C.,

Fig. 3 (above). Case 1. Roentgenogram taken Oct. 21, 1947, showing evidence of healing of the lesion.
Fig. 4 (below). Case 1. Roentgenogram taken June 1, 1948, showing the lesion healed, with residual shortening of talus.

intense swelling and an increase in the specific infiltration of the skin of the face and extremities associated with severe hyperesthesia of hands and feet. Pain was experienced in both ankles three weeks after onset of the febrile period, but definite swelling was not noticed until six weeks had elapsed. This swelling was most severe on the right side, slightly below the level of the ankle joint. Roentgen examination was not made, since bone involvement was not suspected. Fever subsided on the eighty-fourth day of illness, after which the patient was not confined to bed and walked about the infirmary. She again complained vaguely of intermittent pain in the right ankle but this did not become severe until six months after the original onset of fever, when more swelling was noted, together with a flattening of the longitudinal arch and external rotation of the foot.

Roentgen examination at this time showed a destructive lesion of the head and neck of the talus, with involvement of the articulating cartilages between the talus and the navicular and calcaneus (Fig. 5). Healing ensued with the residual deformity of a flat, externally rotated foot with some limitation of motion in flexion and extension at the ankle joint (Fig. 6).

Fig. 5. Case 2. Roentgenogram of right foot, taken June 26, 1948, showing the lesion of the talus which has broken through the articulating cartilage into the talocalcaneonavicular joint as a result of premature weight-bearing.

At no time during the course of the illness was there any evidence of non-specific infection of the overlying skin or in the neighborhood of the lesion nor was there any evidence of intercurrent general infectious disease.

REVIEW OF LITERATURE

A review of the medical literature on bone changes in leprosy revealed no example of a destructive lesion of the talus in the absence of secondary infection of contiguous tissues, perforating ulcers, or other extensive neurotrophic changes.

Cooney and Crosby (2) described destruction of the metatarsal and tarsal bones while the phalangeal bones of the feet were often preserved intact. They were of the opinion that the changes were absorptive in character, stating that while osteomyelitis, osteitis and arthritis may occur, these changes are merely coexistent and not characteristic of leprosy. Silveira (3) described involvement of the tarsal bones secondary to perforating plantar ulcer, also mentioning, specifically, neurotrophic disorganizing arthropathy of the talus with destruction of the articulating cartilages. Rogers and Muir (4) observed complete disappearance of the talus in one case, while the distal ends of the tibia and fibula were worn down into a sharp point which rested in a hole in the dorsum of the calcaneus. This they report took place without

Fig. 6. Case 2. Photograph of feet in standing position, taken July 14, 1948, showing bulging of the inner border of the right foot, some flattening of the longitudinal arch, and abduction of the anterior part of the foot at the mid-tarsal joint.

any necrosis or other septic process but was due solely to trophic changes.

Faget and Mayoral (5), on the other hand, mention osteomyelitis or osteitis of leprous origin in the most distal bones of the extremities but give no example of its occurrence in the tarsal bones. They encountered 5 typical Charcot joints of wrists and ankles in their clinical and radiologic study of 502 patients at Carville, but found this type of neurotrophic involvement much more frequent in the small joints of the hands and feet. They noted that the absorptive process rarely extended higher than the metatarsal bones. Esguerra-Gómez and Acosta (6), in a recent radiologic study of 532 patients, observed mainly neurotrophic involvement of the phalanges, metacarpals, and metatarsals, with "reabsorption" terminating at the carpus in the hands and at Lisfranc's articulation in the feet, although in exceptional instances it reached the cuboid. Bone lesions were also found which they believed to be due to the growth of Hansen's bacilli in the bone marrow and in the osseous tissue. In their wide experience, however, they encountered no lesion of the talus such as is described here (7). Murdock and Hutter (8), firmly believing that osteitis or osteomyelitis is sometimes due to the infective agent of leprosy, mention its occurrence only in the phalanges and the metacarpal and metatarsal bones. Their study was based on 140 patients, 108 of whom showed pathological changes roentgenographically.

The consensus of opinion seems to be that bone changes in leprosy are generally more or less limited to the most distal small bones of the hands and feet, namely, the phalangeal, metacarpal and metatarsal bones, and that the lesions are most commonly the result of neurotrophic disturbances, though occasionally they may be due to the infecting organism. The carpal and tarsal bones appear to be affected only infrequently and then usually in conjunction with extensive neurotrophic changes or with ulceration of the overlying skin. None of the reports in the medical literature mentions a lesion of the talus such as we have described, nor is the possibility suggested that a diseased, deformed, and dislocated talus might serve as the starting point for extensive destruction of other tarsal bones and joints (Charcot joints), following premature and prolonged weight-bearing with gradual attrition of bone substance, especially if the bones are decalcified and rarefied, as occurs frequently in leprosy.

SURVEY

Since the lesion under consideration produced a characteristic roentgen picture and a distinctive deformity in the advanced stages, both of permanent character, roentgen and clinical studies were carried out on all patients at Carville over a six-month period, in the hope of obtaining further information as to the nature and frequency of involvement of the talus. Anteroposterior and lateral views of the feet were taken of 441 patients of whom approximately 85 per

Fig. 7. Roentgenogram of foot, taken March 16, 1948, discovered in the survey. The patient had an acute lepra reaction with onset in December 1943, with pain and swelling developing shortly thereafter in the right ankle. Being a Japanese prisoner at the time, he was forced to walk on the foot in the acute stage. The typical end-result is self-evident.

Fig. 8. Roentgenogram of talus bone showing early lesion in inferior part of neck. A lesion in this location may readily be obscured by the anterosuperior part of the calcaneus.

cent had lepromatous (the great majority of cases being of the mixed type) and 15 per cent neural leprosy.

In 5 patients changes in the talus roentgenographically and clinically similar to the healed lesion noted in our first patient (Fig. 4) were found. A representative film, showing the permanent roentgen changes noted in these patients (Fig. 7) is similar to that obtained in the original case. In another patient the roentgenogram showed a small area of moth-eaten appearance in the inferior portion of the neck of the talus (Fig. 8). This lesion is considered to represent a fairly early stage. Altogether, therefore, 8 patients out of a total of 441, or

1.8 per cent, revealed changes in the talus of unusual nature.

The clinical history of each of these patients revealed that sometime in the past they had had ankle complaints. These complaints were of pain and swelling in the ankle region, of insidious onset, during prolonged attacks of lepra fever. The pain in no instance was severe enough to prevent weight-bearing and the foot became flat and externally rotated, sometimes with slight limitation of flexion and extension at the ankle joint. All patients showing this form of talus involvement had disease of the lepromatous or mixed type.

Extensive destruction involving all the tarsal bones and joints together with marked neurotrophic changes in the metatarsal and phalangeal bones, typical of the disorganizing arthropathies or Charcot joints mentioned by Faget and Mayoral, were observed in several patients having lepromatous or mixed leprosy. None of these was considered comparable to the lesion described in this paper. The probability exists, however, that such extensive tarsal destruction originated with local talus involvement. It is of interest in this connection that in the far-advanced pure neural cases, where marked neurotrophic changes occurred in the metatarsal and phalangeal bones, the tarsal bones usually remained well preserved.

DISCUSSION

The evidence for the origin of this lesion is overwhelmingly in favor of a specific infection with *M. leprae.* Unfortunately, a biopsy specimen for histologic study could not be secured and therefore the nature of the condition is not beyond doubt. The following points, however, constitute strong presumptive evidence in favor of an infectious process rather than the result of the more common absorptive phenomenon due to nerve involvement:

(1) The onset of the lesion occurred during lepra reactions, when bacilli are most numerous in the blood and recrudescence of old leprous lesions and formation of new ones are apt to occur.

(2) The talus is a very vascular bone. The site of its involvement was observed to be in the location of its best blood supply, *i.e.*, at the junction of the neck and head.

(3) The talus transmits the entire body weight from the tibia to the foot. Thus it is exposed to constant trauma. In leprosy, local injury to body tissues may determine the formation of a lesion, probably due to a local weakening of resistance.

(4) The lesion occurred only in patients having lepromatous or mixed leprosy, the types showing a considerable number of bacilli in skin lesions. Also, the secondary neural element was only minimal at the time of occurrence of the lesion. This is a point decidedly in favor of an infectious process. Furthermore, it has been observed that pure neural cases of leprosy, in which it is normally extremely difficult or impossible to recover the organism, and in which extensive neurotrophic absorption of the phalangeal and metatarsal bones is seen frequently, do not generally present extensive lesions of the tarsal bones unless accompanied by secondary infection or trophic ulcerations. Mixed leprosy usually shows the most marked and destructive bone changes.

(5) Healing of the lesion occurred fairly rapidly. This is a characteristic of leprous osteitis, which is considered to have a strong tendency toward regeneration (4). If the process had had a neurotrophic basis, it would be expected that the condition would have progressed beyond involvement of the head and neck without a tendency toward healing.

(6) The possibility of a non-leprotic origin appears to be excluded, as no other general infectious disease was present, nor was there a previous history of any such disease. Although the lesion developed in the epiphyses of the talus and under the cartilage, as is characteristic of a tuberculous process, it did not extend to the neighboring joints except where secondary trauma from weight-bearing occurred, or as an abscess along the periosteum or the tendon sheaths. The similarity of this lesion to tuberculous osteitis in itself suggests

an infectious etiology rather than a neurotrophic one.

A non-specific infectious involvement from local extension of a surrounding infection does not seem likely in the absence of perforating ulcers or any other type of skin ulceration or non-specific skin infection. Also, in pyogenic infection of bone there is rapid destruction with no regeneration.

The insidiousness of the onset of this talus lesion deserves special emphasis. The intermittent occurrence of ankle pain is easily confused with leprous neuritis. Swelling of the ankles occurs frequently in leprosy, especially during acute lepra reactions. Furthermore, roentgen examination fails to give definite evidence of a lesion in the very early stages. Because of these factors, it is an easy matter to overlook the condition until weight-bearing has produced a splay foot.

In this connection it should be pointed out that a roentgenogram taken of the ankle region from a lateral position is essential. An anteroposterior view, with good detail in demonstration of the most peripheral small bones, may not show enough detail of the more proximal bones to allow discovery of a lesion of the talus. Care should be exercised in taking the lateral view to secure full visualization of the lower surface of the head and neck of the talus. Sometimes the anterosuperior part of the calcaneus may overlie and obscure the presence of the lesion.

Among the patients examined in the survey several instances of extensive involvement of all the tarsal bones and joints in the foot were observed, similar to the neurotrophic disorganizing arthropathies or Charcot joints described in the medical literature. A lesion of the talus bone such as is shown in Figures 2 and 5, followed by prolonged weight-bearing with chronic and acute trauma, complicated by decalcification or rarefaction of surrounding bones and other neurotrophic changes, might easily serve as the origin of such extensive destructive involvement.

CONCLUSIONS

The talus bone is believed to be susceptible to specific leprous involvement. Such a complication of leprosy is considered to be of unusual occurrence. It has not previously been reported in the medical literature.

This lesion of the talus bone has an unusually insidious onset and presents signs and symptoms which can easily be confused with those of an accompanying acute lepra reaction until a deformity occurs.

Although a conclusive histopathologic study of the lesion concerned is lacking, a preponderance of evidence supports the assumption that it is a specific infectious lesion due to *M. leprae*.

The lesion presents a characteristic roentgenologic and clinical picture. It is capable of producing a splay foot, such as is observed in fracture of the neck of the talus, if weight-bearing is allowed prior to healing.

Recognition of this lesion as early as possible is important from the standpoint of treatment to obviate the development of a severe deformity.

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(Para el sumario en español, véase la página siguiente.)

SUMARIO

Extraña Lesión del Astrágalo en la Lepra

En dos enfermos con lepra (forma lepromatosa) descubrióse una extraña lesión destructora del astrágalo, caracterizada clínicamente por dolor y edema del tobillo y por iniciación insidiosa durante la evolución de una reacción leprosa. Roentgenológicamente, resultó difícil distinguir las alteraciones óseas en las primeras etapas. Más tarde, pudo descubrirse una zona de menor espesor, de aspecto apolillado, hasta que por fin se afectaron toda la cabeza y el cuello del hueso. En el primer caso, la lesión terminaba bruscamente en los cartílagos articulares; en el otro, presuntamente por haberse cargado el peso a una edad temprana, el proceso destructor continuaba a través del cartílago hasta penetrar en la articulación talocalcaneonavicular, dando por resultado un pie plano, tal como se observa en las fracturas del astrágalo. Ni en uno ni otro caso había ulceración o solución de continuidad en la piel sobreyacente, ni enfermedad infecciosa asociada.

El estudio de otros 441 leprosos reveló cinco casos con alteraciones semejantes a la lesión cicatrizada observada en el primer caso descrito, mientras que otro enfermo (el sexto) mostraba una zona apolillada que se consideró representaba un período temprano de invasión. En todos esos casos, la historia clínica era comparable a la suministrada por los dos enfermos descritos.

Aun a falta de un estudio histopatológico terminante de la lesión mencionada, la mayoría de los datos disponibles apoya la suposición de que se trata de una lesión infecciosa específica debida al *M. leprae*.

Desde el punto de vista del tratamiento, es importante reconocer dicha lesión cuanto antes a fin de evitar la aparición de una deformidad grave.

A Method of Double-Contrast Roentgen Examination of the Small Intestine[1]

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ADVANCES IN accuracy of diagnosis of lesions in the esophagus, stomach, duodenal bulb, and colon have far surpassed achievements in demonstration of organic lesions of the jejunum and ileum. Though great strides have been made by Mackie (25), Snell and Camp (39), Golden (19), Pendergrass and Comroe (31) and others in the demonstration of functional changes in the bowel, adequate examination of the small intestine and satisfactory delineation and demonstration of its lesions remain a challenge to the radiologist.

There are three principal reasons for lack of progress in roentgen diagnosis of small bowel lesions: (1) the time-consuming nature of the examination; (2) difficulty in interpretation of minor changes in the bowel; (3) the extremely low incidence of organic disease in this part of the digestive tract, so that the examiner has little to show, in the way of positive diagnoses, for the effort expended in many examinations.

It is the purpose of this paper to review the various methods of examination of the small intestine, furnishing a background for the development of the double-contrast technic used in selected cases in the University Hospitals (Minneapolis).

CURRENT METHODS OF EXAMINATION OF THE SMALL BOWEL AND REVIEW OF THE LITERATURE

Oral Administration of Barium: The method most frequently employed in the roentgen examination of the small intestine is the so-called "motor meal," more recently designated by Golden as "the intestinal study" (19). It is based on the administration of barium sulfate by mouth in varying quantities and concentration. Morse and Cole (29) described a standard technic for the procedure in 1927 and Golden subsequently modified this, administering a mixture of 120 gm. of barium sulfate suspended in 4 or 5 ounces of physiological saline solution. He recommended that films be made at half-hour intervals for a period of five to six hours, with fluoroscopy two or three times during this interval and spot films to demonstrate areas of suspected anatomical variations.

Weber and Kirklin (43, 44, 45) use 8 ounces of a mixture of equal parts (by volume) of water and barium sulfate. The patient is examined roentgenoscopically at fifteen-minute intervals, spot films being obtained as indicated. When the stomach is almost empty, a palatable meal is given for the purpose of stimulating peristalsis and accelerating the passage of the head of the meal into the terminal ileum and colon. The usual delay in filling of the terminal ileum is thus avoided.

Åkerlund (6) uses a thinner mixture, consisting of three parts of barium sulfate to four parts of water and stresses especially the fluoroscopic examination.

In 1937 Pansdorf (30) advocated fractional filling of the small intestine by administering the barium mixture in four 1-ounce doses at fifteen-minute intervals.

Hodges (23), aware of the time-consuming nature of small bowel examination, adopts a practical approach for screening of patients. After the initial fluoroscopic examination of the stomach and observation of the passage of the barium meal into the jejunum, he eliminates further fluoros-

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copy, making full abdomen roentgenograms, usually at intervals of one hour, two and one-half hours, and five hours after the ingestion of the meal, though the technic is not so rigid as to prevent variations as the case requires. Patients who show some changes in the course of this screening examination are subjected to more exhaustive study.

Interesting observations were made by Pendergrass, Ravdin, Johnston, and Hodes (32) on the effects of foods and various pathological states on gastric emptying and the small-intestine pattern.

Visualization of the Ileum by Retrograde Filling from an Enema: Most roentgenologists agree that examination of the terminal ileum is well accomplished by retrograde filling of the ileum from a barium enema. In many cases, however, the competency of the ileocecal valve cannot be overcome and the ileum fails to fill. In these cases barium must be taken by mouth.

Intubation of Duodenum and "Enteroclysis" or "Small Bowel Enema": In 1943 Schatzki (35) demonstrated that, with the injection of barium through an indwelling duodenal tube, the entire small intestine could be completely examined in a single session. This awakened new interest in a procedure which had been reported in the early part of the century by Einhorn (12) and Cole (9) and later by Buckstein (8) and Pesquera (33).

In 1938 Ghelew and Mengis (18) in Switzerland, and in 1939 Gershon-Cohen and Shay (17) in America, described the injection of air and contrast medium into the small intestine, in a double-contrast procedure.

Wissenberg (48), in 1942, reported 21 cases examined by small bowel enema or enteroclysis according to the method of Gershon-Cohen and Shay, with demonstration of a few abnormal findings. Wissenberg's publication was not available in this country until after the war, when communications with Scandinavia were reestablished.

The Miller-Abbott Tube: The greatest stimulus to the study of the small intestine was afforded by Miller and Abbott (27) in 1934, when they published their first article on intestinal intubation, describing the double-lumen tube used by them in physiological experiments for measurement of foodstuff absorption and for making kymographic records of intraluminal pressure. One lumen led to an inflatable rubber bag at the tip of the tube, while the other contained perforations through which aspiration of intestinal contents and injection of material into the intestine could be accomplished. The bolus stimulus of the inflated bag would carry the tube through the intestine and, if allowed to continue, on through the rectum. The authors gave credit to Scheltema (36) and Einhorn (13) for providing the background for their technic.

In 1936 Abbott and Miller (1) described a triple-lumen tube making use of two balloons spaced about 30 cm. apart, each of which could be inflated through its own lumen independent of the other. The segment of tube lying between the balloons was provided with holes for injection of material and aspiration of intestinal contents. In this manner the authors were able to isolate a small segment of bowel to measure absorption of food materials and to collect pure intestinal secretions from local areas of the bowel. In 1938 Abbott (3) and his co-workers reported the use of the triple-lumen tube for injecting barium into a closed loop of small intestine isolated in this manner.

The fundamental work of Wangensteen and Paine (42), demonstrating the value of duodenal suction as an adjunct in the treatment of intestinal obstruction, appeared in 1935.

In 1938, Abbott and Johnston (2) published an account of the use of the Miller-Abbott tube in treating, localizing, and diagnosing the nature of obstructing intestinal lesions. These authors pointed out that the nature of an obstructive lesion could be determined by injection of barium through the tube at the site of obstruction. They also recommended aspiration of intestinal contents for examina-

tion for blood as a diagnostic procedure (2, 4, 28).

In 1939, Lofstrom and Noer (24) described their experience with the use of a tube in the localization of obstructive lesions of the gastro-intestinal tract, presenting a few illustrative cases. They specifically stated that they were making use of a triple-lumen tube in a further study of the mucosal pattern of the bowel, but no such cases were included. Boon (7) also published his experience with intubation for the demonstration and localization of partially obstructive lesions. Although this work was published in England, the author's experience with the tube was obtained at the University of Pennsylvania Hospital.

All physicians who have used Miller-Abbott tubes for diagnostic or therapeutic purposes are aware that the greatest obstacle to their use is the difficulty of passage through the pylorus. To facilitate this, Sivertsen (38) (quoted by Wangensteen) in 1941 suggested the use of mercury in the balloon to weight the tip of the tube and thus utilize the effect of gravity in carrying it through the pylorus. In 1944, Wild (46) in England and Harris (21) in this country also recommended the use of mercury at the tip of the tube, both as an aid in its passage into the duodenum and to give added motility.

In 1944, Mayer (26) suggested the use of a highly magnetic alloy tip for the tube, with an electromagnet to manipulate the tip through the pylorus.

Special Modification of Intubation Technics: As early as 1911, Cole (9) had used an intubation technic for the special purpose of demonstrating duodenal lesions. He used an Einhorn dilator with a small rubber bag at the tip connected to a rubber tube which he inflated to obstruct the duodenum. He then filled the obstructed duodenum with contrast medium. Einhorn (12) also used this method and in 1913 published some roentgenograms obtained with its aid. Shiffer (37), at the University of Pennsylvania, was the first to use the Miller-Abbott type of tube for a similar procedure. He reported obturation of the duodenum with such a tube in 30 cases.

In 1927, Pribram and Kleiber (34) described the use of a double-contrast technic in visualization of the duodenum. Following insufflation of a small quantity of barium and air through an indwelling duodenal tube, they produced some excellent roentgenograms of the mucosal folds of the duodenum and demonstrated some ulcer niches. This is probably the first reference to double-contrast examination of any portion of the small intestine.

EXAMINATION OF SMALL BOWEL BY DOUBLE CONTRAST

Description of Triple-Lumen Tube: In view of the extensive work by many investigators, and as a result of a discussion with Dr. Louis Zetzel (50), it was believed that a triple-lumen tube, such as that described by Miller and Abbott, could be used for double-contrast study of the small bowel.

The tube constructed for this purpose is of rubber. At the proximal end is a metallic adapter with three outlets, each fitting into a separate lumen in the tube. A rubber balloon is fitted to the distal end of the tube and a second balloon is arbitrarily spaced 25 cm. from the first. Each balloon can be inflated independently, as it communicates with the proximal end of the tube by its own lumen. Between the balloons, in the third lumen, are eight equally spaced holes through which injection of contrast material and aspiration of intestinal contents can be accomplished.

With the tube in position in any portion of the small bowel and with both balloons distended, a "closed loop" is created. This loop can be uniformly distended and filled with barium and air for demonstration of the mucosal pattern. Overlapping of bowel loops and filling of the entire abdominal field with the contrast materials are obviated. The distended balloon at the distal end of the tube and the more proximal one constitute an ideal obstructing mechanism to prevent dispersal of the

contrast material outside of the area in which examination is intended.

Technic of Examination: The tube is tested for patency of the lumens and for leaks in the balloons, and passage of the tip into the stomach is facilitated in the usual manner. Under fluoroscopic control the tube is passed through the pylorus, with the necessary manipulation so that there shall be no coiling in the stomach. An interval timer is used to prevent an excess of radiation to the skin. If the tip has not advanced beyond the pylorus after five minutes of fluoroscopy, 2.0 c.c. of metallic mercury is introduced into the lumen leading to the distal balloon. The patient is then placed at rest on the right side and examined at 15-minute intervals until the tube has entered the duodenum. Rotation of the patient in various degrees of obliquity may aid the passage of the tube. When the duodenum has been entered, the distal balloon is inflated with 20 to 25 c.c. of air and allowed to progress through the small intestine to the point at which examination is intended. The tube is fed through the nostril at a rate of one foot an hour.

Abbott and Miller (1) had demonstrated that obstruction of the bowel can be maintained with the balloons distended to a pressure of 20 to 30 cm. of water. Later, Zetzel and Banks (49) used phasic pressures varying from 30 to 40 cm. of water. In our technic the readings were from 25 to 40 cm. With some experience, it was determined that with a balloon of fixed size this pressure range could be maintained by 45 c.c. of air, and from that time manometric readings were no longer taken. These are obstructive pressures and the procedure must be carried on rapidly from this point because of the mild cramp-like pains occurring in most patients. If the patient is free from distress with the balloons blown up to this extent, it is obvious that there is some change in intraluminal pressure. We have found this a fair indication of some form of chronic obstruction with change in pressure pattern as demonstrated by Abbott *et al.* (5).

The bowel contents in the isolated segment of the intestine are aspirated with a 100-c.c. syringe and 30 to 40 c.c. of a thin mixture of barium sulfate (one part of barium and two parts of water by volume) is introduced, the patient being manipulated so as to distribute the barium smoothly throughout the isolated loop. If the bowel has been properly evacuated, the barium will coat the mucosa in satisfactory fashion. Following this, 150 to 200 c.c. of air is injected into the lumen of the bowel. The filled loop is observed fluoroscopically to the best advantage and spot films are made. In addition, multiple films are obtained in the prone position.

The majority of patients can tolerate the slight cramp-like pains incident to this procedure for a long enough time for the films to be checked. If decompression of the loop of bowel occurs as a result of failure to maintain pressures within the balloons, re-examination can be attempted at the session without producing undue discomfort. As soon as the procedure is completed, the balloons are immediately decompressed under fluoroscopic vision to determine that all air has been aspirated, and the tube is withdrawn if desired. If therapeutic decompression is necessary, the tube can be left within the bowel as an adjunct to therapy, or, if surgery is intended, to guide the surgeon to the site of the pathological process.

For demonstration of the first and second portions of the duodenum by double contrast, experience has shown that the two-lumen tube operates to greater advantage. When the proximal portions of the duodenum are included in a "closed loop" and distended, the marked flow of biliary, pancreatic, and intestinal juices will result in "puddling" of the injected barium in the accumulated fluid, and the mucosa will not be coated as is necessary for a successful double-contrast examination (see Fig. 5). This can be obviated by use of a single-balloon tube with the opening into the bowel distal to the balloon. The distended balloon obstructs the pylorus and prevents a reflux of the injected barium

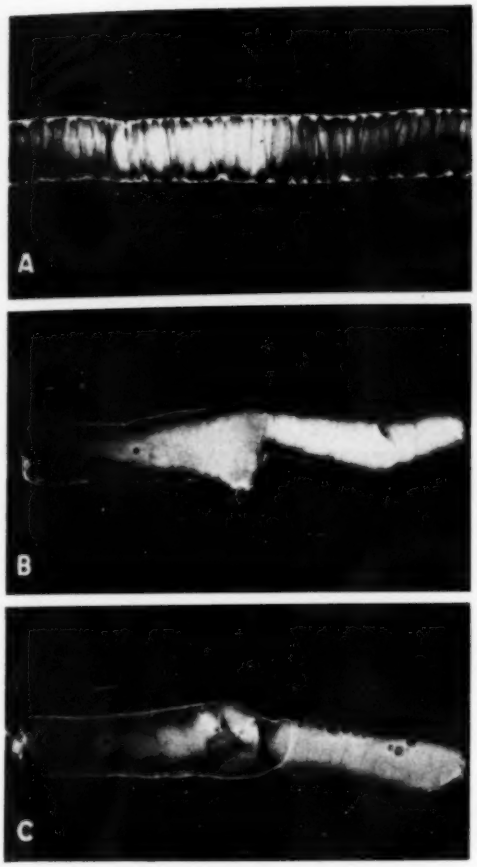


Fig. 1. Double-contrast roentgenograms of autopsy specimens of small bowel.

A. Jejunum. Note valvulae conniventes and uninterrupted delineation of the wall by adherent barium coating. B. Ileum. The valvulae conniventes are not prominent, and the bowel presents a characterless pattern. A Meckel's diverticulum is visualized in profile. C. Ileum. The Meckel's diverticulum is demonstrated *en face*.

and air into the stomach. The duodenal fluid contents flow freely into the jejunum and thus do not interfere with the examination. This technic was used in a few instances by Pribram and Kleiber (34) in 1927.

The Roentgen Anatomy of the Small Intestine as Visualized by the Double-Contrast Method: The mucosal pattern of a loop of jejunum and proximal ileum distended with gas, as in a case of obstruction, will show the closely approximated valvulae

Fig. 2. Distal duodenum and proximal jejunum visualized by double-contrast study in a normal subject. Note demonstration of valvulae conniventes, absence of secondary folds, and sharp pencil-like demarcation of the bowel wall by barium adherent to the mucosa.

conniventes or Kerkring's folds. The distended distal ileum will be "characterless" in comparison, and on the roentgenogram will show no folds (41). When the jejunal mucosa is coated with barium and the jejunum is distended with air, the picture is similar to that seen in intestinal obstruction and on the distended autopsy specimen. The coating of the mucous membrane surface and luminal distention will usually appear as a continuous line demarcating the edge of the wall, seen in profile, indented only by the Kerkring's folds (Fig. 1). The distal ileum will, of course, show no folds. In Figure 1B and C, it is of interest to note a Meckel's diverticulum visualized by double contrast in profile and *en face*.

The mucosal pattern as seen with double-contrast technic in the normal subject is similar to that of the fresh autopsy specimen, providing the pressure of distention is moderate. As the pressure decreases, the secondary folds, so aptly described by Forssell (14, 15, 16) and later by the Cole Collaborators (10), can be seen (Figs. 2, 3, 9C). However, when the secondary folds become more prominent, the sharp

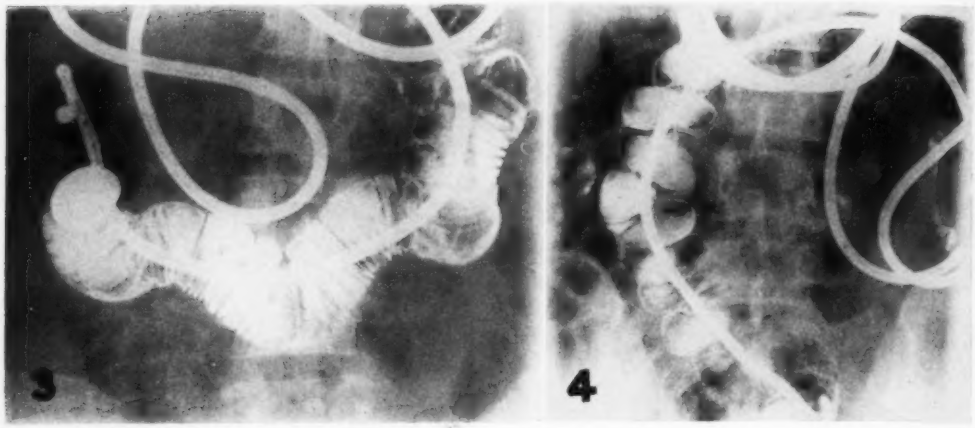


Fig. 3. A mid-jejunal loop examined by the double-contrast technic demonstrates the valvulae conniventes and the absence of secondary folds. The "bent spring," spiral pattern of Kerkring's folds is well demonstrated in this case.

Fig. 4. An isolated loop of distal ileum in a normal subject demonstrated by double contrast. Kerkring's folds are absent in the distal ileum when the bowel is distended. Note the coiled appearance of the bowel reefed on the Miller-Abbott tube.

delineation of the unbroken line of the barium coating is less striking. It is of interest to note that in cases with prolonged obstruction the valvulae conniventes are more widely spaced than in healthy subjects.

In the distal ileum in most cases, there is found a reefing of the bowel on the tube, as shown in Figure 4. This demonstrates in striking fashion why the tip of a 9-foot Miller-Abbott tube can present itself at the rectum with the proximal end at the nostril. It may be that improvement in technical factors can be accomplished with a plastic tube of greater internal caliber for aspiration with attached fine caliber tubes for inflation of the balloons. A tube of this nature has been in use at the University of Minnesota Hospitals by Doctor J. J. Wild (47) for the past two years. Publication of his work will appear later. Herrera and his co-workers (22) have utilized a Koroseal plastic tube, as reported in November 1947.

GENERAL DISCUSSION

Use of Oral Administration of Barium and Its Shortcoming: For demonstration of functional changes of the small bowel, the most physiological method of visualizing the intestine, by oral administration of a barium sulfate and water mixture, is the method of choice. For demonstration of organic lesions this technic is in many cases unsatisfactory, for the following reasons: (1) The pylorus offers an obstruction to the free flow of the contrast material, and the loops of small bowel are incompletely and unpredictably filled. (2) With too great filling of the loops, because of overlapping and superimposition, detail is obscured. (3) Functional changes in the bowel secondary to intrinsic lesions and to disease of the mesentery confuse the picture. (4) In case of total bowel obstruction, the administration of barium by mouth is objectionable. (5) In cases of partial bowel obstruction, the barium is so diluted by the fluid in the distended loops that little detail of the mucosal pattern can be made out, and the only information to be obtained from such examination is the site of the obstructing lesion; its nature is indeterminate (21, 44).

Advantages and Disadvantages of the Small-Bowel Enema: The small-bowel enema, as advocated by Schatzki (35), offers some improvement over the oral method. The bowel loops can be distended to better advantage and more care-

fully studied during fluoroscopy, and functional changes of the mucosal pattern are considerably reduced. However, the overlapping of the loops and the presence of barium throughout the entire bowel make identification and interpretation of the lesions difficult. Frequent reflux into the stomach has greatly interfered with the passage of the barium through the gut and often prevents completion of the examination. Like the oral administration of large quantities of barium, the small bowel enema is hazardous in cases of complete obstruction.

Indications for Use of Double-Contrast Technic, with Case Presentations: The advantages of intubation studies in the diagnosis of lesions of the bowel have been demonstrated by many. Improvement in technic and accuracy in diagnosis develop with experience on the part of the radiologist. The nature of the obstructing lesion is best demonstrated by injection of small quantities of barium through the tip of a decompressing Miller-Abbott tube. Frequently, however, with use of the orthodox two-lumen tube, barium will disperse itself proximal to the obstructing point and an adequate picture of the mucosal pattern will not be obtained. As demonstrated heretofore, the best method for visualizing mucosal pattern is with double contrast. For this purpose, barium sulfate and air prove a satisfactory combination.

The triple-lumen tube with a double balloon is an ideal apparatus for obtaining double-contrast visualization of the mucosa of a short isolated segment of the small intestine. In cases of non-obstructing lesions, one attempts to interpose the involved segment between the inflated balloons and, with it thus isolated, to distend it by the injection of small quantities of barium and air. If the lesion is obstructive in nature, it will prevent the further passage of the tip of the tube and the distal balloon. In this event, the proximal balloon is inflated to prevent regurgitation of the barium, while the lesion itself acts in place of the distal balloon as an obstructing mechanism. Barium and air are then injected into the loop and study of the mucosal pattern at the site of obstruction is possible (Fig. 6).

Fig. 5. Visualization of a "closed loop" of duodenum and proximal jejunum in a normal subject. The jejunal portion of the loop is adequately visualized. The barium is puddled in the fluid-filled duodenum and demonstration of that portion is unsuccessful.

The following case demonstrates the use of the double-contrast technic in the diagnosis of a completely obstructing lesion.

CASE 1: A 78-year-old female was admitted to the University of Minnesota Hospitals on Aug. 16, 1947, with a history of nausea, vomiting, and alternate constipation and diarrhea two months previously. These symptoms relented somewhat, and no definite diagnosis had been made. The week preceding admission the patient had no severe abdominal cramps but vomited two or three times daily and had no bowel movements, though she had observed bowel sounds and visible peristalsis.

On admission to the hospital, the abdomen was distended but not remarkably tender. Severe cramps were not present, but many borborygmi were heard. Following immediate intubation and institution of Wangensteen duodenal suction, symptoms disappeared.

On Aug. 20, a triple-lumen Miller-Abbott type of

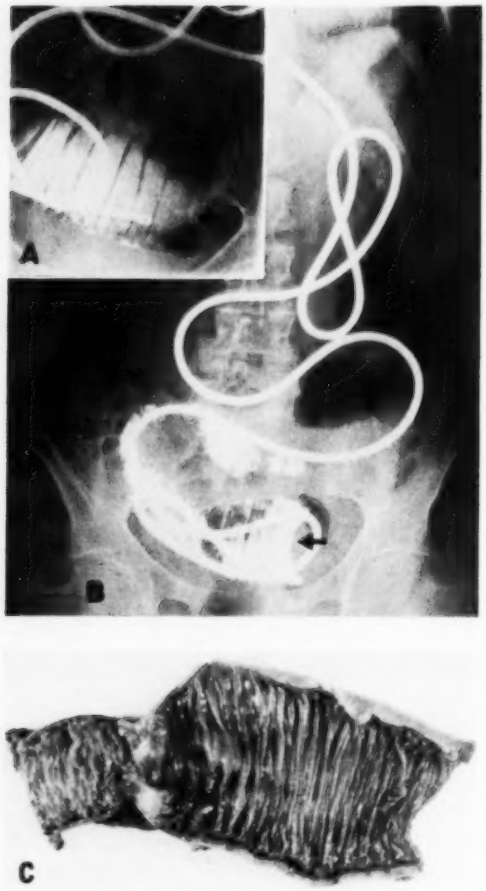


Fig. 6. Case 1: Adenocarcinoma of the jejunum with complete obstruction.

A. Demonstration of obstructing lesion by double contrast material injected distal to the proximal obstructing balloon. The mucosal pattern of the distended bowel is intact. The Kerkring's folds are widely spaced. The invagination of the bluntly obstructed end of the loop suggests the presence of a tumor.

B. Twenty-four hours later the character of the complete obstruction is demonstrated. The cuff defect with overhanging edges is characteristic of carcinoma of the bowel.

C. Surgical specimen showing markedly constricting adenocarcinoma of the jejunum. Note normal mucosa of the distended proximal loop and overhanging edge of distended bowel around the tumor.

tube was passed. It reached a point in the left lower quadrant of the abdomen in two hours, advancing no further in twenty-four hours. Injection of the lumen with a small quantity of barium and air was accomplished. The proximal balloon in this case was distended with 50 c.c. of air, shutting off the intestine at that point. The distal balloon was deflated and the loop of bowel lying between the proximal balloon and the obstructing lesion was examined by double-contrast study. The mucosal pattern showed only wide spacing of Kerkring's folds. The obstruction was complete and there was invagination of the bluntly obstructed end of the loop, suggesting a tumor (Fig. 6 A and B).

At operation on Aug. 27, an adenocarcinoma was found constricting the small bowel, with metastatic involvement of adjacent mesenteric lymph nodes (Fig. 6C). The tumor and nodes were resected and the patient recovered.

With partial obstruction, the mucosal pattern is well demonstrated and the change from a normal pattern to ulcerated or infiltrated areas, in the presence of tumor, has been demonstrated. Cases 2 and 3 illustrate the differentiation of a partially obstructive lesion due to neoplasm and one due to adhesive bands.

CASE 2: A 67-year-old white female was admitted to Ancker Hospital on June 24, 1946. Six days before admission she had experienced cramp-like abdominal pain. Vomiting began the following day and had been almost continuous since that time. The patient stated that a number of years previously she had had several attacks of cramp-like pain lasting for an hour or two, which were relieved without treatment. Thirty-two years previously a hysterectomy had been performed. Physical examination revealed abdominal distention with audible borborygmi.

The symptoms were relieved, and the patient was discharged from the hospital at her request, remaining on a soft diet of her own volition. On Sept. 3, 1946, she returned, having had, in the interval, three distinct attacks of crampy abdominal pain and vomiting, with distention of the abdomen, all following the ingestion of solid food. She had lost 20 pounds in the past six weeks. At the time of readmission she was again asymptomatic and no distention or tenderness was noted. On June 26, 1946, a small amount of gas in slightly distended loops of small bowel had been observed roentgenographically. Inasmuch as diarrhea was present and there was no evidence of complete obstruction, barium was administered, revealing an obstructive lesion in the ileum. Overlapping of distended loops of bowel and dilution of the barium at the point of obstruction made identification of the lesion impossible (Fig. 7A), and on Sept. 5, intubation was done.

The tip of the Miller-Abbott tube reached the site of obstruction in a few hours and failed to advance further in twenty-four hours. Study of the loop of bowel proximal to the obstruction showed an indentation of the wall. The mucosal folds were not obliterated and the wall was well demarcated. These findings were indicative of an indentation due to a broad fibrous adhesion (Fig. 7B).

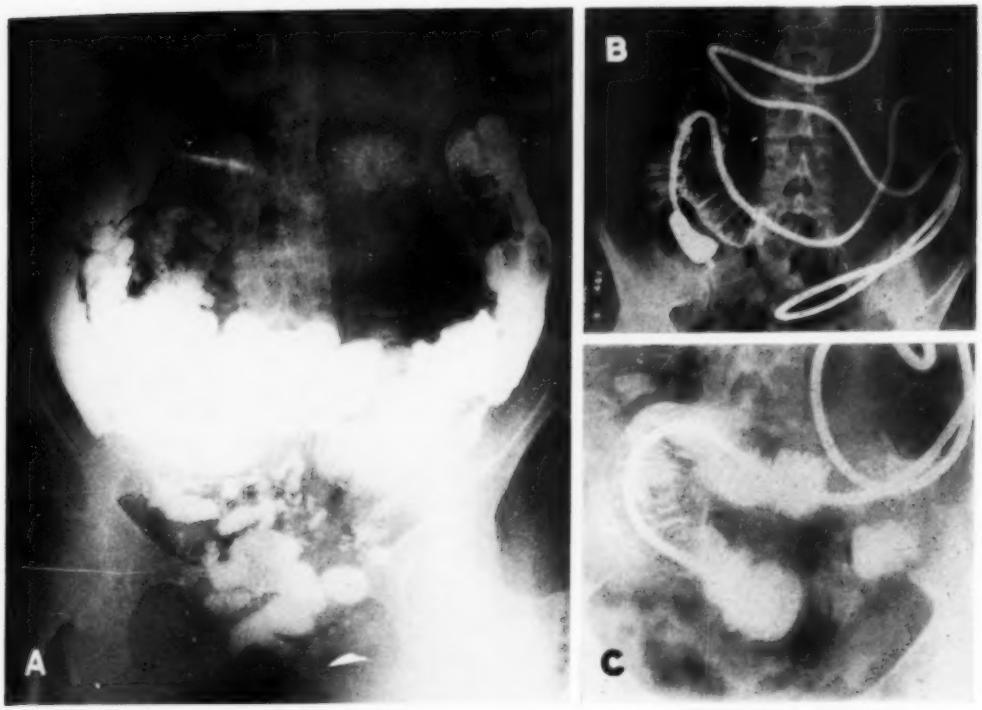


Fig. 7. Case 2: Incomplete obstruction of proximal ileum due to fibrous bands.
A. Conventional twenty-four-hour roentgenogram demonstrating dilated loops of small bowel proximal to obstruction and segmental distribution of barium in non-dilated ileum distal to obstruction. Barium in the colon helps to obscure the obstructing lesion. The mucosal detail of the obstructing lesion could not be brought out at fluoroscopy.
B. Loop of ileum proximal to the point of obstruction demonstrated by double-contrast study. Arrows point to indentation of the lower portion of the loop by adhesive bands. Note absence of mucosal change.
C. Tapering obstructive lesion with no destruction of mucosal folds, due to a fibrous adhesive band with knuckling.

The distal balloon was then deflated, and the barium tapered to the obstructive point without obliteration of the mucosal pattern, a characteristic observation in obstruction due to fibrous bands (Fig. 7C).

The patient was operated upon on Sept. 17, and firm adhesions were found deep in the pelvis. There was a constricting band in the lower jejunum, which would barely permit the passing of a finger, and the bowel was sharply kinked in that area.

CASE 3[2]: A 69-year-old female was admitted to the Miller Hospital in St. Paul on May 20, 1947, complaining of anorexia, weight loss, and anemia for about one and one-half years. The anemia had been unsuccessfully treated with liver and iron for the past year. Six weeks before admission the patient began to experience intermittent attacks of crampy low abdominal pain with nausea and vomiting. These attacks had become more frequent.

[2] We are indebted to Doctor Harold O. Peterson of St. Paul for the privilege of reporting this case.

Roentgen examination of the stomach and upper small bowel showed the proximal jejunum markedly distended. No definite visualization of the mucosal pattern was obtained at the point of obstruction. The barium was diluted in the distended loop (Fig. 8A). On May 26, 1947, intubation was done; barium and air were introduced into the distended bowel, and a tumor was visualized (Fig. 8B).

The tumor, with 15 cm. of dilated bowel, was removed. It was nodular, projected into the lumen, and its surface was ulcerated and necrotic. It proved to be an adenocarcinoma.

In discussing Lofstrom and Noer's paper (24) in 1939, Abbott pointed out that in small bowel intubation "there is no universally correct apparatus . . . whether one allows the barium to enter the gut ahead of the balloon, behind the balloon, or decides to use a three-lumened tube and inject into

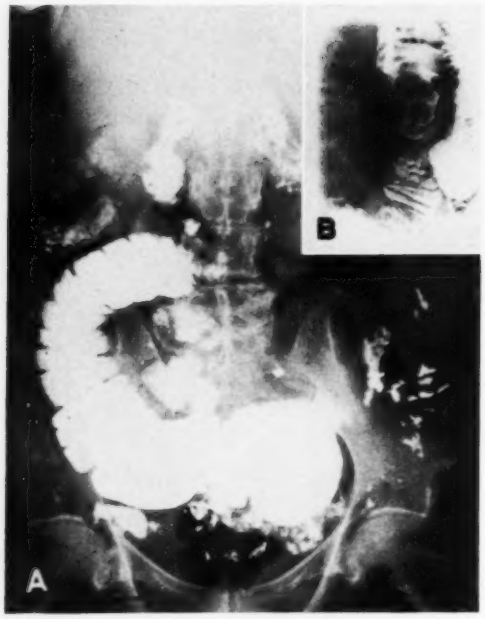


Fig. 8. Case 3: Adenocarcinoma of the jejunum. (Case of Dr. Harold O. Peterson)

A. Conventional film showing partial obstruction of the jejunum. No mucosal detail can be detected at the site of the obstruction.

B. Double-contrast demonstration of abrupt ending of the normal mucosal pattern and infiltration of the bowel wall. Polypoid filling defects are demonstrated. Normal mucosal pattern is shown distally.

a segment of gut between two balloons, must be decided for the individual case."

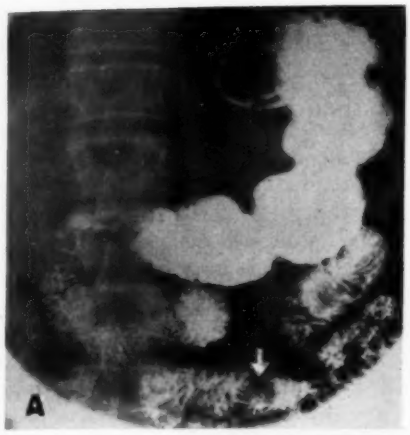
This would presume that the condition present could be determined prior to intubation and the correct tube be chosen for the particular case. Such knowledge, however, is not always available. As the case progresses, if the examiner decides to inject barium in another manner than is possible with the indwelling tube, he must withdraw that tube and reintubate, thus doubling a long and painstaking operation. With a triple-lumen tube, the barium can be injected between the balloons, in front of the proximal balloon, or behind the distal balloon as the examiner elects when the lesion is encountered, without change of tube. With such a tube he can best make use of the double-contrast technic.

If the examiner desires, when the tube is part way through the small intestine, he may utilize the small intestinal enema to visualize the distal portion of the gut by simply obturating the bowel through distention of the proximal balloon. With this procedure, less barium will be needed for the examination and the number of filled overlapping loops will be decreased.

In many cases, organic lesions of the small bowel manifest themselves by symptoms suggesting intermittent episodes of incomplete bowel obstruction, or the patient may present himself for examination with complete obstruction. In another group gastro-intestinal hemorrhage, not explained by a demonstrable lesion in the esophagus, stomach, duodenal bulb, or colon, is the principal finding. The foregoing comprise the clinical findings suggesting small-bowel lesions in the majority of cases. There is, however, a smaller group of cases which give vague, indeterminate symptoms referable to the gastro-intestinal tract in which no lesion of stomach, colon, or gallbladder is found. Many of these patients are labeled as psychoneurotics, and this diagnosis is probably often correct. However, frequently enough to embarrass the clinician and radiologist a lesion in the small bowel may eventually be discovered.

The methods of examining patients with obstructing lesions have been adequately discussed. Those cases manifested by gastro-intestinal hemorrhage present a more formidable problem. The most serious error made by both clinician and radiologist in such cases, in which no lesion is found in esophagus, stomach, or colon, lies in failure to investigate the small intestine.

No other source of bleeding having been discovered, intubation with a triple-lumen tube, with constant aspiration of intestinal contents should be done. At regular intervals the aspirated contents should be tested with guaiac solution for the presence of blood. When a positive test is obtained, examination of the bowel should be done at that point, the apparent site of bleeding. This technic has been recommended by Abbott and Johnston (2) and



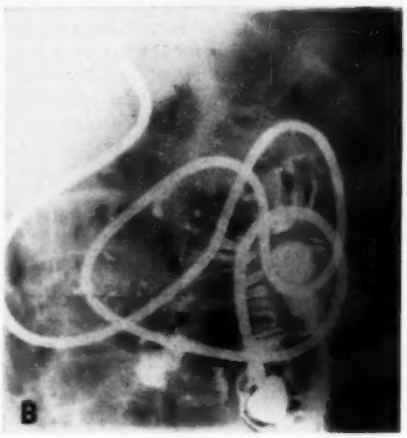


Fig. 9. Case 4: Roentgen diagnosis of tumor of jejunum (unproved).

A. Arrows point to persistent small defect in the proximal jejunum in a patient with pain in the left upper quadrant and occult blood in the stool, for which no source was found in the esophagus, stomach, duodenal bulb, or colon.

B. Investigation of suspected area by intubation and double-contrast technic. Arrows indicate area of abrupt interruption of jejunal wall and obliteration of mucosal folds. The passage of barium beyond the distal balloon was due to slow deflation of the balloon during the procedure.

Golden (19). The use of the double-contrast examination of the local segment of bowel insures a satisfactory examination.

In the smaller group of patients requiring examination of the small bowel for a suspected organic lesion which does not manifest itself by obstruction or hemorrhage, a screening procedure such as the oral

C. Re-examination at a later date with a new tube. The lesion is again demonstrated. Note appearance of secondary mucosal folds with decreased intraluminal pressure.

administration of barium is necessary. If a suspicious area is observed, that segment of the bowel should be investigated by intubation with the three-lumen tube. This is by far the most difficult application of the method. It is illustrated by the following cases.

CASE 4: A 41-year-old white male was admitted to Ancker Hospital on Dec. 1, 1946, with upper and lower abdominal pain, chiefly on the left. The pain increased in severity, was cramp-like for one day, and then became almost constant. The patient had passed tarry stools for a few days before admission. He complained of nausea but had not vomited.

Physical examination showed abdominal tenderness, with slight rigidity of the left rectus muscle and some rebound tenderness. Occult blood was found in the stool on two occasions.

Roentgen study of the stomach and colon revealed no lesion. On Dec. 20, 1946, a small-bowel motor meal demonstrated a somewhat localized, rather sharply defined filling defect in a loop of jejunum near the fourth lumbar vertebra (Fig. 9A). Further examination was suggested to evaluate this finding, and a special double-contrast examination was done on Jan. 8, 1947.

With the area of jejunum under investigation localized between two distended balloons, obliteration of Kerkring's folds was noted. There was an abrupt end of delineation of the normal bowel wall in this area (Fig. 9B). A roentgen diagnosis of neoplasm of the jejunum was made. Since the films were not of perfect quality because of loss of air from the isolated bowel loop, re-examination was done on Jan. 12, with the same findings (Fig. 9C).

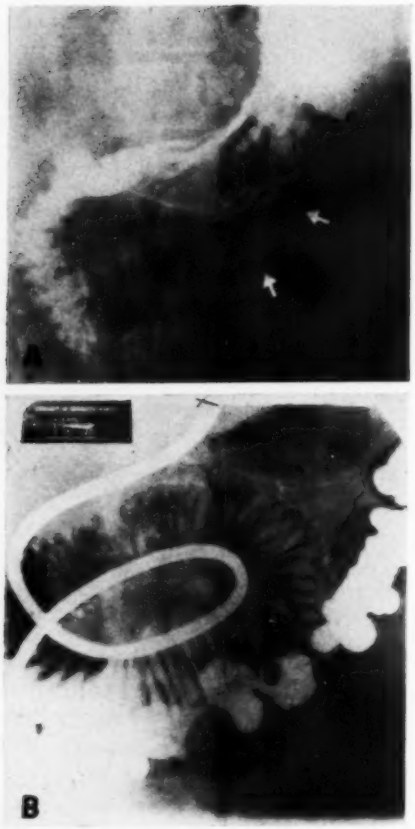


Fig. 10. Case 5: Duodenal tumor suspected on an examination of the stomach and disproved by double-contrast study.

A. Arrows point to a defect in the third portion of the duodenum which simulated an ulcerating neoplasm. Spot-film with the patient in supine position.

B. Intubation study the following day with double-contrast technic shows a normal duodenum and proximal jejunum. A cholecystectomy was subsequently performed, and the duodenum was explored and proved to be normal.

Operation was performed on Jan. 15. The proximal portion of the jejunum was moderately dilated, edematous, and slightly thickened, and some fresh adhesions were observed. These appeared soft and separated freely; the adjacent bowel was hyperemic and bled slightly. The bowel was not resected, however, nor was it explored intrinsically. The patient complained of the same symptoms immediately following the operation, and at one time vomited profusely, with some blood in the vomitus. A second laparotomy three months later showed very extensive adhesions in the abdomen with the same thickened and edematous bowel. Lysis of the adhesions was done and no effort to explore the bowel was made.

As a corollary it should be emphasized that the double-contrast method of examination has also great "negative" value. Frequently, on roentgen examination of the upper gastro-intestinal tract, one may observe some local variation in the small-bowel pattern or some minor defect may suggest the presence of a small-intestinal lesion. Double-contrast examination of the suspected area may be of decided help in disproving the presence of a lesion.

The following case illustrates this point to good advantage.

CASE 5: A 34-year-old female was admitted to the University of Minnesota Hospitals on Feb. 26, 1947, complaining of recurring attacks of right upper quadrant pain and chills and fever, occasionally accompanied by jaundice, for the past four and one-half years. She was intolerant to fatty meat and fish. The last severe attack was approximately one month before admission. The patient was moderately obese, with a small umbilical hernia and a questionable mass in the left upper quadrant of the abdomen.

Cholecystography revealed fair concentration of dye and no definite evidence of calculi. On the gastro-intestinal roentgen study an irregular defect of the third portion of the duodenum near the ligament of Treitz was noted, and a neoplasm of the duodenum was considered (Fig. 10A). Intubation of that portion of the duodenum and of the proximal portion of the jejunum, with double-contrast examination, showed no abnormality (Fig. 10B). Cholecystectomy was done and the duodenum was explored and proved to be normal.

In a small-bowel study, one is often confronted with the problem of differentiating the picture of "disordered motor function" primarily due to a functional state from that of "disordered motor function" secondary to disease within the small bowel or in the mesentery. In the latter case, it is of extreme importance to demonstrate the pathological process in the bowel, which in the routine small-bowel study is obscured by the superimposed functional changes.

CASE 6: A 19-year-old Mexican girl, admitted to Ancker Hospital in December 1945, for treatment of pulmonary tuberculosis, experienced anorexia without nausea, vomiting, or abdominal pain and was referred to the x-ray department for study of the gastro-intestinal tract.

The colon was found to be normal, as were the

esophagus and stomach. Marked changes in the small-bowel pattern were observed, with the characteristic findings of "disordered motor function" of the small intestine. Figure 11A is a roentgenogram made two hours after the ingestion of barium. Two days later visualization of the proximal jejunum showed a normal mucosal pattern in a normally distended loop (Fig. 11B).

Use of the double-contrast technic was not attempted in patients with suspected tuberculous enteritis. In view of the frequent spontaneous rupture of tuberculous ulcers of the small bowel, it was thought hazardous to subject a possibly tuberculous ulcerated area to increased intraluminal pressure.

SUMMARY AND CONCLUSIONS

A review of the routine methods of small bowel examination is presented.

The technic of double-contrast visualization of the small intestine with use of a three-lumen Miller-Abbott tube is described, and the roentgen anatomy as demonstrated by this procedure is illustrated. By this means, changes in the mucosal pattern are adequately visualized.

Six cases are reported to demonstrate some varied pathological changes which may be studied in this manner.

The indications for the use of the triple-lumen tube for double contrast examination of the small bowel are as follows:

1. In cases of a suspected small bowel lesion in which examination with a barium meal demonstrates an indeterminate defect.
2. In cases in which, during examination of the stomach and on study of the films, one finds a "suspicious" area in the small bowel requiring further evaluation.
3. In cases of "disordered motor function" in which an organic lesion of the small intestine is suspected.
4. In cases with gastro-intestinal hemorrhage and gross or persistent occult blood in the stools, for which no obvious cause is found in the esophagus, stomach, or colon. In these cases constant aspiration of intestinal contents should be done during the passage of the tube, with repeated testing with guaiac solution. If the test proves positive, the bowel is then examined at the site of bleeding.
5. In cases of complete or partial obstruction of the small bowel. The triple-lumen tube should be passed to the obstructing point; the proximal balloon should then be inflated and barium and air

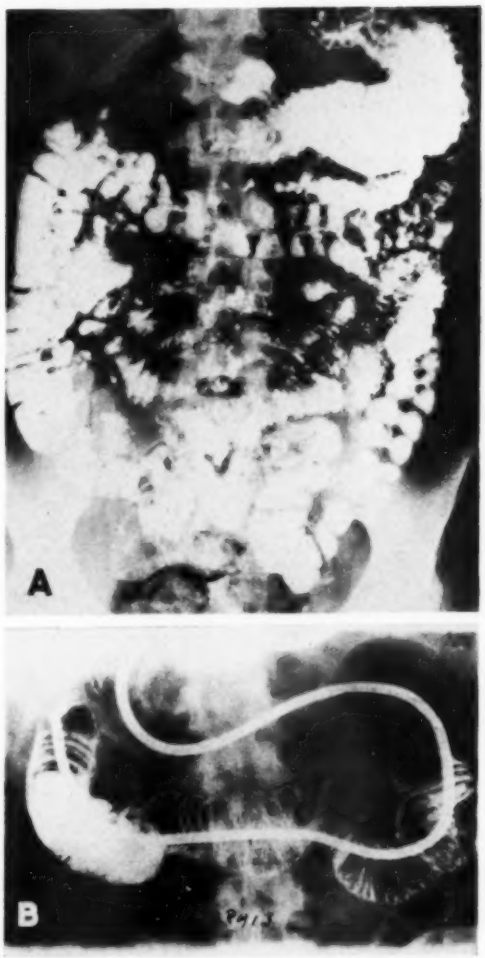


Fig. 11. Case 6: "Disordered motor function" of the small bowel in a 19-year-old girl with pulmonary tuberculosis.
A. Two-hour conventional roentgenogram showing characteristic segmentation, coarsening of mucosal folds, and irregular dilatation and contraction of the loops. Barium in the colon was retained after a barium enema the day previously.
B. Intubation forty-eight hours later, with double-contrast visualization of the proximal jejunal loop, shows a normal mucosal pattern.

injected distal to the distended balloon. If obstruction is definitely known to be present, a two-lumen tube may be used, provided the only opening into the bowel lumen is at the tip of the tube distal to the obturating balloon.

In cases of obstructing lesions, the diagnostic use of the tube is also an adjunct in therapy, as a decompressive agent. In all cases in which a lesion is demonstrated and is surgically explored, the tip of the tube directs the surgeon to the site of the lesion, and postoperatively the same tube is used for decompression.

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SUMARIO

Técnica del Doble Contraste para el Examen Roentgenológico del Intestino Delgado

Después de repasar los métodos corrientes para el examen roentgenológico del intestino delgado, descríbese una técnica de doble contraste que utiliza la sonda de Miller-Abbott. Con la sonda en posición y ambos balones inflados, se crea un asa intestinal cerrada, que puede distenderse y llenarse homogéneamente de bario y aire para revelar el patrón de la mucosa.

Comunícanse seis casos para mostrar algunas variaciones patológicas que pueden estudiarse de este modo.

Las indicaciones para el empleo de la sonda de tres vías en el examen de doble contraste del intestino delgado son las siguientes:

1. Casos en que se sospecha lesión del intestino delgado y en los que el examen con una comida de bario revela una deformación imprecisa.

2. Casos en que, durante el examen del estómago y al estudiar las radiografías, se descubre una zona "sospechosa" en el intestino delgado que exige nueva justipreciación.

3. Casos de "disfunción motriz" en que se sospecha además la presencia de una lesión orgánica del intestino delgado.

4. Casos de hemorragia gastrointestinal y de sangre macroscópica u oculta persistente en las heces, sin descubrirse causa manifiesta en el esófago, estómago o colon. En esos casos, debe realizarse la aspiración constante del contenido intestinal durante el paso de la sonda, con repetida comprobación con solución de guayaco. Si la prueba resulta positiva, se examina entonces el intestino en el sitio aparente de la hemorragia.

5. Casos de oclusión total o parcial del intestino delgado. Hay que introducir la sonda de tres vías hasta el punto obstruído: se inflará entonces el balón proximal, inyectándose bario y aire más allá del balón distendido. Si se sabe positivamente que hay oclusión, puede usarse una sonda de dos vías, con tal que la única abertura a la luz intestinal quede en el extremo de la sonda distal al balón obturador.

En casos de lesiones obstructoras, el empleo diagnóstico de la sonda constituye además un coadyuvante terapéutico, como descompresor. En todos los casos en que se descubra una lesión y se explore quirúrgicamente, el extremo de la sonda encamina al cirujano al sitio de la lesión, empleándose postoperatoriamente la misma sonda para descompresión.

Ileal Prolapse[1]

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PROLAPSE OF THE mucosa of the terminal ileum into the cecum is apparently a rare condition. We have been able to find only 4 cases recorded in the literature, in all of which hypertrophy of the ileocecal valve was also present. At the Cincinnati General Hospital we recently encountered this condition in 2 patients. Each one presented a radiographically demonstrable filling defect in the cecum, the appearance of which so closely simulated neoplasm that operation was performed, but the only lesion found was prolapse of ileal mucosa into the cecum. There was no evidence of associated hypertrophy of the ileocecal valve in either case.

CASE 1: K. G., a 70-year-old white housewife, was first seen in the Gastric Clinic of the Cincinnati General Hospital on June 2, 1947, complaining of cramps, abdominal pain, and alternating diarrhea and constipation of two and a half weeks duration. She had passed no blood, pus, or mucus in the stools and had not lost weight. Since the onset of the present illness there had been loss of appetite, epigastric discomfort, distention after meals, and "sour stomach." Vomiting had not occurred.

The past history was essentially negative. The patient had attended the Out-Patient Department since 1930 for various minor ailments. There had been no previous operations. Physical examination was normal.

Barium enema examinations were performed on June 6 and June 27. The colon appeared normal except for a constant, sharply defined, round, smooth-surfaced filling defect in the cecum, 5 cm. in diameter (Fig. 1). The defect could not be moved about within the cecum, but the cecum itself was movable. The filling defect was especially well seen following evacuation of the barium and on the air-contrast study (Fig. 2). No barium entered the terminal ileum. A roentgen diagnosis of polypoid tumor of the cecum was made.

The patient was admitted to the hospital on July 14. Symptoms and physical findings were unchanged. Sigmoidoscopy to 21 cm. showed no abnormalities. Laboratory studies were normal except for a hemoglobin of 12.5 gm. Three stool examinations were negative for gross or occult blood. Oral cholecystography revealed a normally functioning gallbladder with no evidence of calculi. A roentgenogram of the chest was normal.

Fig. 1. Case 1: Sharply defined, smooth-surfaced filling defect in the cecum caused by prolapse of ileal mucosa into the cecum and demonstrated by barium enema.

On July 27, under cyclopropane anesthesia, the abdomen was opened through a transverse incision in the right lower quadrant. There was no free peritoneal fluid. The cecum and terminal ileum were normal in appearance. The mesenteric lymph nodes were not enlarged. Careful palpation of the cecum revealed the presence of a soft, sessile, lobulated mass, 3 cm. in diameter, attached to the posterior wall of the cecum and protruding into its

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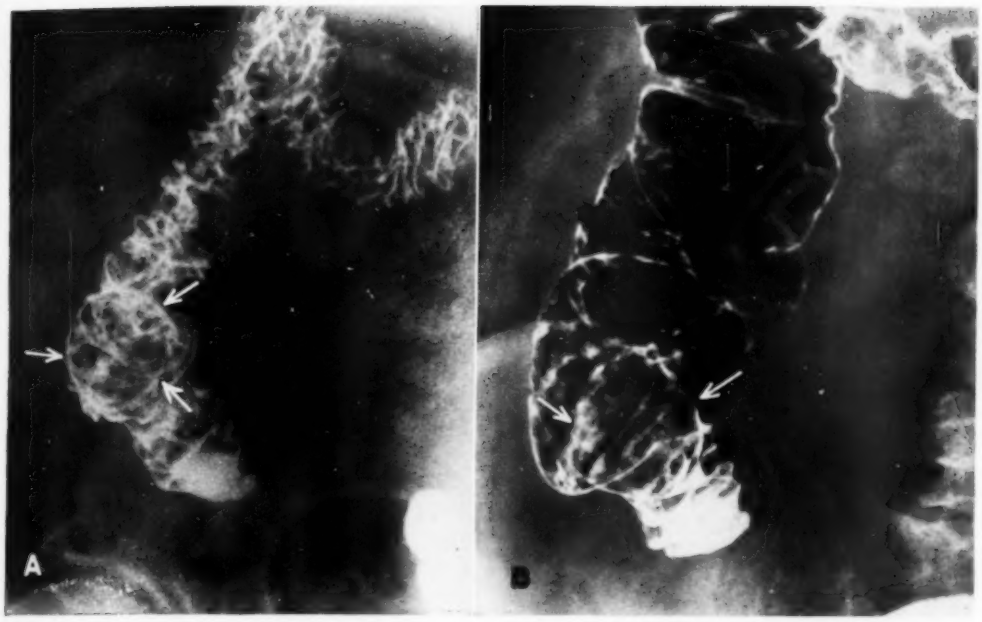

Fig. 2. Case 1: Demonstration of the cecal defect. (A) Following evacuation of barium and (B) on air-contrast study.

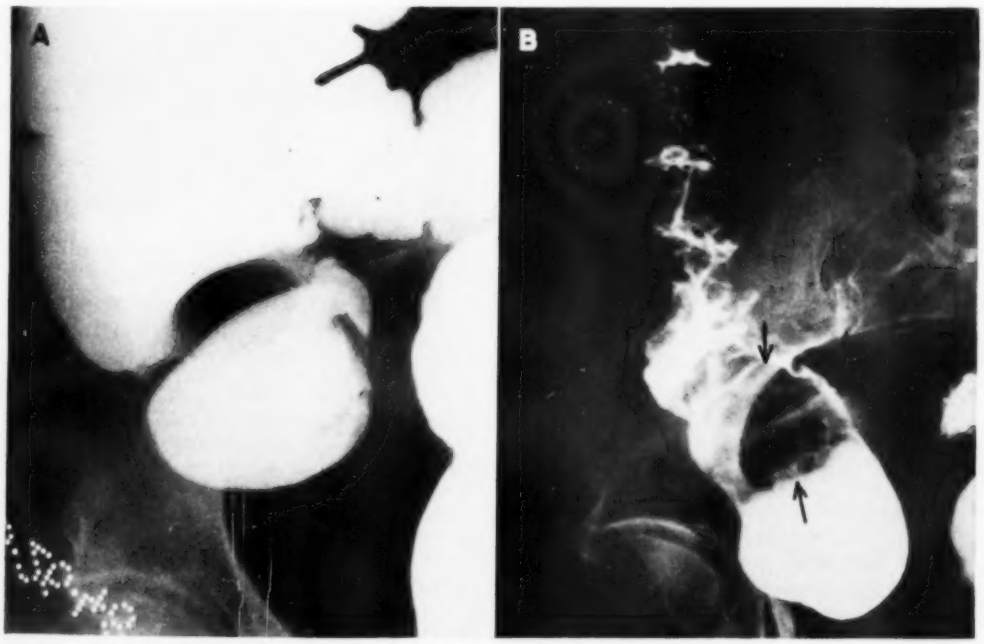

Fig. 3. Case 1: Following exploratory cecotomy, the same defect is demonstrated in the cecum by barium enema. (A) Immediately following barium enema. (B) Post-evacuation.

Fig. 4. Case 2: Small bowel study revealing a well defined rounded polyp-like mass in the cecum due to prolapsed ileal mucosa.

lumen. The cecum was opened through the anterior longitudinal muscle band. A circular mass of normal ileal mucosa was found protruding through the ileocecal valve into the cecum. There was no induration or edema of the prolapsed mucosa or of the ileocecal valve. The mucosa could be replaced manually into the ileum without difficulty, but upon release of pressure prolapse promptly recurred. There was no evidence of intussusception. The lumen of the prolapsed ileum easily admitted two fingers, so that the possibility of a future obstruction appeared very unlikely; therefore no further procedure was performed. The cecotomy and abdominal incisions were closed. Recovery was uneventful.

The patient was followed in the Gastric Clinic and was last seen in May 1948, at which time she had no complaints. Bowel movements were entirely normal. Barium enema examination on May 26, 1948, ten months after operation, revealed no change in the original filling defect (Fig. 3).

Case 2 (reported through the courtesy of Drs. David L. Graller and Paul I. Hoxworth): J. McF., a 20-year-old white male bacteriologist, first consulted his physician on Jan. 20, 1948. He gave a history of rhinitis and sinusitis three weeks prior to this date, with subsequent weakness, vomiting, and diarrhea. He lost four pounds in weight. The earlier history was not remarkable. Physical examination revealed no abnormalities.

Laboratory studies showed agglutination for tularemia to be positive 1 to 640. The Kahn test was negative. The stools contained occult blood.

The acute symptoms disappeared but, because of persistence of occult blood in the stools, studies of the gastro-intestinal tract were made. An upper gastro-intestinal series on Jan. 26 was normal except for the demonstration of a small diverticulum arising from the superior angle of the duodenal loop. Barium enema examination on March 2 was interpreted as showing a normal colon and terminal ileum. A small bowel study on March 25 revealed a questionable small filling defect in the cecum at six hours (Fig. 4). The barium enema was repeated on March 29 and again a small polypoid defect in the cecum was suggested.

Fig. 5. Case 2: Repeat small bowel study demonstrating the cecal defect.

A second small-bowel study was performed on May 10 and a definite small, round, regular, smooth-surfaced defect was demonstrated in the cecum. A barium enema was again given on May 15, and following evacuation the origin of the defect could be traced to the region of the ileocecal valve.

The patient was admitted to the Jewish Hospital on June 17. At that time he was complaining of occasional nausea and vomiting and vague right lower quadrant discomfort. Physical examination was entirely normal.

On June 22, a laparotomy was performed under sodium pentothal anesthesia by Dr. Paul I. Hoxworth. The cecum was opened for a distance of 4 inches; tubular extension of the mucosa of the terminal ileum into the cecum for a distance of approximately 2 inches was found. No other abnormalities were seen. There was no edema of the ileocecal valve and no evidence of obstruction. The

normal appendix was removed and the abdomen was closed. The patient was discharged on July 1, since which time he has been asymptomatic.

DISCUSSION

Golden (4) has reported 2 proved cases of hypertrophy of the ileocecal valve associated with bulging of the ileal mucosa into the cecum. The protrusion of the mucosa was thought to be the result of "pouting" or eversion of the enlarged lips of the valve. In each instance barium enema examination revealed a filling defect in the region of the ileocecal valve which was interpreted as a polypoid tumor of the cecum. Golden states that edema of the ileocecal valve is a common finding in surgical specimens studied following ileocolectomy for terminal ileitis. He believes that the roentgen demonstration of a rounded cecal defect calls for a study of the small bowel for regional enteritis.

Strömbeck (8) described a case with similar roentgen findings which at operation were shown to be due to an enlargement of the ileocecal valve with bulging of ileal mucosa into the cecum. Terminal ileitis was also present.

In a case reported from the Massachusetts General Hospital (1), a barium enema examination showed a defect in the cecum which suggested hypertrophy of the ileocecal valve. At operation, prolapse of 2.5 to 3.5 cm. of ileal mucosa into the cecum was found. The edge of the protruding tissue resembled the end of a cornet horn. A finger could be passed freely through the lumen of the protruding tissue into the terminal ileum. Since there was no obstruction in the ileocecal region, no further procedure was carried out. The anatomical diagnosis was hypertrophy of the ileocecal valve. In the discussion of this case, Castleman stated that he had encountered hypertrophied ileocecal valves at autopsy in the absence of past symptoms suggestive of chronic intussusception.

Fleischner (3) states that slight protrusion of ileal mucosa into the cecum, forming a "rosette-like roll," is not an uncommon finding in normal anatomic specimens. He adds that larger herniations producing radiologically demonstrable filling defects are less frequent. His exhibit at the meeting of the Radiological Society of North America in 1947 included several cases of ileal prolapse.

Fig. 6. Case 2: Following evacuation of the barium enema, mucosal folds can be traced back toward the ileocecal valve.

Other cases of prolapse of ileal mucosa into the cecum have been recognized but not reported (6, 7, 9).

From the literature it would appear that hypertrophy of the ileocecal valve and ileal prolapse almost always occur together, the prolapse being the result of eversion of the swollen valve. In both of our cases, however, the ileocecal valve was normal and the defect in the cecum was caused solely by the prolapsed mucosa. Ileal prolapse, therefore, is not necessarily due to inflammation or other abnormalities of the ileocecal valve.

It appears unlikely that the *symptoms* in our patients were related to the ileal prolapse, since they disappeared completely without a definitive operative

procedure. The occult blood in the stools in Case 2 remains unexplained.

The *roentgen findings* in our cases and in the cases reported in the literature are similar. Ileal prolapse produces a rounded filling defect in the cecum, varying in size with the amount of mucosa protruding through the ileocecal valve and showing a smooth and regular surface. With pressure over the cecum it may be possible to trace the origin of the defect to the valve. The cecum itself is freely movable, but in neither of our cases was the defect movable.

DIFFERENTIAL DIAGNOSIS

Carcinoma of the cecum, especially in its early stages, may simulate ileal prolapse roentgenologically, but the filling defect is often irregular and the adjacent mucosal pattern may be abnormal.

A *polyp* or other benign tumor of the cecum may produce a smooth round defect indistinguishable on x-ray examination from ileal prolapse. An inverted *appendiceal stump* may also cause such a defect (2, 10).

Hypertrophy of the ileocecal valve appears to be commonly associated with ileal prolapse, and, according to Golden (5), the two conditions cannot be distinguished roentgenologically. There is frequent association of enlargement of the valve with regional enteritis.

Ileocecal intussusception is not likely to be confused with ileal prolapse by the radiologist because of the typical dome-shaped filling defect, transverse markings, and widened lumen in the former. The clinical symptoms and physical findings aid in differentiating the two conditions.

Inflammatory lesions should offer little difficulty in differentiation from ileal prolapse. The presence of irritability, irregular filling defects, and marginal involvement of the colon should eliminate ileal prolapse from consideration.

Since some of the above conditions can produce a smooth round filling defect in the cecum, their roentgen differentiation from ileal prolapse is often difficult or impossible. The presence of such a defect in the vicinity of the ileocecal valve, in the absence of evidence of regional enteritis and with no history of previous appendectomy, should suggest the possibility of ileal prolapse. Thus far, however, it appears that an unequivocal preoperative diagnosis is not possible.

SUMMARY

Prolapse of ileal mucosa into the cecum through the ileocecal valve is apparently a rare condition. In the few cases reported in the literature it has occurred secondary to edema of the ileocecal valve with resultant bulging of the mucosa of the ileum into the cecum. Prolapse of redundant ileal mucosa, however, may occur without associated abnormality of the valve.

Two cases are presented, in each of which a filling defect in the cecum shown by barium enema examination was mistakenly interpreted as a polypoid tumor. In both instances operation revealed only prolapse of ileal mucosa into the cecum, with no evidence of hypertrophy of the ileocecal valve.

While the roentgen changes in the cecum may suggest the possibility of ileal prolapse, a preoperative differentiation from more serious conditions cannot be made with certainty.

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SUMARIO

Prolapso Ileal

El prolapso de la mucosa ileal al ciego a través de la válvula íleocecal es aparentemente un estado raro. En los pocos casos comunicados en la literatura, fué secundario a edema de la válvula íleocecal, dando éste por resultado proyección al ciego de la mucosa del ileon. No obstante, puede ocurrir prolapso de la exuberante mucosa ileal sin anomalía concomitante de la válvula.

Preséntanse dos casos, en ambos de los cuales un nicho en el ciego revelado por el examen con un enema de bario fué interpretado erróneamente como tumor polipoideo. En ambos casos la operación mostró únicamente prolapso de la mucosa ileal al ciego, sin signos de hipertrofia de la válvula íleocecal.

Si bien el hallazgo roentgenológico de un nicho redondeado en el ciego con una superficie lisa y regular puede indicar la posibilidad de prolapso ileal, no cabe hacer con certeza la diferenciación preoperatoria de otros estados más graves.

Dosage Distribution and Dosage in Carcinoma of the Uterine Cervix[1]

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THIS PAPER WILL describe briefly the Manchester approach to the treatment of carcinoma of the uterine cervix under three main headings: (*a*) what we wanted to do when in 1937 we started working on this subject; (*b*) how we decided to do it; (*c*) the results we have obtained and conclusions that we can draw from them.

What we wished to do was to treat carcinoma of the uterine cervix and to do so primarily by means of radium. More than this, it was regarded as essential that any method we should devise must be such that we could easily calculate and state the number of roentgens delivered, for it is only when dosage is expressed in terms of roentgens that any real progress can be made. A further requirement was that the method to be devised should be capable of delivering the same dose in roentgens regardless of the size of the patient or the size and shape of the tumour being treated.

Any radiological method must be able to produce a high dose zone which is roughly the shape of the tumours that are likely to be met in practice. In the case of carcinoma of the uterine cervix, this shape is not a simple one. The tumour involves part or all of the cervix, its predominant line of spread is laterally through the paracervical tissues into the parametrium, while it may also extend upwards into the uterus as far as the fundus, and downwards into the vagina, growing over the vault in any direction. Rarely, however, except in very advanced cases, does the tumour infiltrate forward into the bladder or backwards into the rectum, so that we are left with having to treat a zone which is roughly trefoil in section and has small thickness forwards or backwards.

When this work was started, Paterson and Parker (1) had just completed their now famous dosage system and we should very much have liked to have been able to apply this system to treatment of carcinoma of the cervix, but this was considered impracticable and we had to employ, like Stockholm and Paris before us, an intracavitary method. Thus we cannot achieve homogeneity of irradiation and have to be content with a dose which falls from the radium outwards. This in turn means that we must select some point at which to state our dosage in roentgens. In the choice of this point, three main considerations arise. First, it must be anatomically comparable from patient to patient; second, the dose there must not be highly sensitive to small alterations in the position of the radium which do not materially affect the treatment as a whole; finally, most important of all, it must be such that it can be used for the correlation of general radiation effect with radiation dose. Our choice of point was guided by the work of T. F. Todd (2), which showed that the initial lesion of radiation necrosis is due ordinarily to high dosage in the region where the uterine blood vessels are crossed by the ureter. This region we have called the paracervical triangle (3), its approximate position being shown in Figure 1.

Since we may regard the tolerance of this zone as a limiting factor in the irradiation of carcinoma of the uterine cervix, it seemed reasonable to choose a point there for dosage specification (3). This point, designated A, is 2 cm. lateral to the central canal of the uterus and 2 cm. from the mucosa of the lateral fornix in the plane of the uterus. Because we also wanted some idea of the "throw" of dose towards the

[1] From the Holt Radium Institute, Manchester, England. Read before the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5-10, 1948.

pelvis, we calculated the dose at a second point, B, which is at the same level as A but 5 cm. out. Point B is sufficiently near the obturator node to give a reasonable idea of the dose there.

In order to produce the desired trefoil-shape high-dose zone, we divide our radium between a line of tubes in the uterus and two applicators in the vagina, one as far out as possible in each lateral fornix. The vaginal applicators—we have called them ovoids for the sake of brevity—are essentially modifications of the corks of the Paris technique. Usually they are made of hard rubber, although recently we have been making our own of Poly Vinyl Chloride. In shape they are approximately ellipsoids of revolution with a hole along the axis to take one or more radium tubes of 2.2 cm. length. Three sizes are available, having equatorial diameters of 2.0, 2.5, and 3.0 cm., respectively. If space will allow, they are held 1 cm. apart by a rubber spacer, but if the vagina is too small for this, a rubber washer may be used; this allows the ovoids to lie practically in contact. Thus we have six possible combinations of paired ovoids and washer or spacer, and one or other of these can be used in the large majority of cases.

The intra-uterine applicators are also available in three sizes—to take one, two, or three radium tubes in line—and they are made of thin rubber, since we believe that it is extremely important to avoid dilation of the cervix, which may tear a way open for sepsis or the dissemination of malignant cells. The applicators are closed at one end and at the other end have a thin rubber flange. This flange, in use, lies against the cervix, and the intra-uterine tube is held in position by the washer or spacer and the vaginal packing.

The question now to be answered is how can we distribute the radium in such a way that the dose rate at point A is independent of the particular applicators used. In allocating radium to produce the desired effect, one further point must be remembered, *i.e.*, that the tolerance of the vaginal mucosa, though very high, is not unlimited.

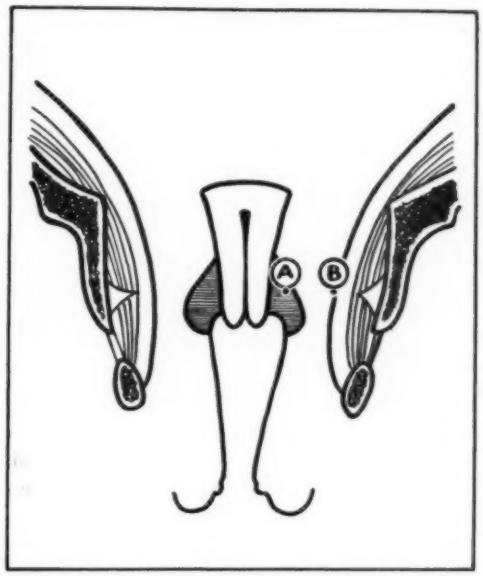

Fig. 1. Approximate position of the paracervical triangle and the dosage statement points A and B.

In fact, a rough working rule is that not more than half of the total dose at point A should come from the vaginal radium.

TABLE I: DETAILS OF LOADING AND DOSE AT POINT A

(*a*) Applicator Loading

Vaginal ovoids			
Large (3.0 cm. diam.)	5 units each		
Medium (2.5 cm. diam.)	4 units each		
Small (2.0 cm. diam.)	3 units each		
Intra-uterine applicators (counting from fundus to cervix)			
Long (3 radium tubes)	2	2	1 units
Medium (2 radium tubes)	2	1	units
Small (1 radium tube)	2		units

(*b*) Dose at Point "A" in 24 hours

Mg. Radium taken as Unit	Dose
5	1000 r
6.66	1333 r
10	2000 r

Table I (*a*) gives details of the loading of the different applicators in terms of "units" so as to fulfil the condition just mentioned and to give reasonable constancy of dose rate at point A for whichever combination of applicators is used. With such loading, the total variation of dose at point A for the whole range of applicator combinations possible is within ± 10 per cent of the dose from the most commonly used arrangement, namely, two medium-sized ovoids (2.5 cm. in diameter) with an intra-uterine applicator taking two medium tubes in

TABLE II: TREATMENT POLICY

	Dose at Point A	Dose at Point B	Tumour Lethal Dose at
Stages 1 and 2			
Radium 3 days	4000 r	1550 r	3.5 cm. from mid line of uterus at level of A
Interval 4 days			
Radium 3 days	4000 r	1550 r	
Total in 10 days	8000 r	3100 r	
Stages 3 and 4			
Radium 3 days	3500 r	1400 r	5.0 cm. from mid line of uterus at level of A
X-ray 24 days	2400 r	3000 r	
Radium 3 days	3500 r	1400 r	
Total in 5 weeks	9400 r	5800 r	

line. The actual dose at point A depends, of course, on the amount of radium which is taken as a unit, as shown in Table I (*b*).

Though this type of arrangement of radium applicators gives a reasonably good "throw" of dosage outwards towards the pelvic wall, it cannot, for safe doses at point A, deliver a tumour lethal dose to point B, and therefore the need for supplementary x-ray therapy may arise. The purpose of such additional irradiation is to extend the high-dose zone laterally towards the pelvic wall. Since the region of the cervix is adequately irradiated by the radium, our x-ray beams are directed towards point B and the cervix region is shielded as much as possible. The method we use, which is essentially an eight-field technique using 10 × 4-cm. fields at 40 cm. F.S.D. and with 250-kv. radiation, has recently been fully described by Paterson (4).

Our present treatment policy is based on two surveys of past cases made by Dr. M. C. Tod. She showed in the first survey (5) that for Stages 1 and 2 results obtained with radium alone were as good and possibly actually better than those obtained by radium with supplementary x-rays. For Stages 3 and 4, where greater lateral spread of the tumour will have taken place, the survey showed the definite value of supplementary x-ray therapy. Our present plan, therefore, summarised in Table II, is that patients in Stages 1 and 2 are treated with radium alone, receiving two insertions each lasting about three days and separated by four days, while patients in Stages 3 and 4 receive an approximately three-weeks course of x-ray therapy between the first and second radium insertions.

Tod's later survey (6), of 1,500 cases, was made to try to establish the optimum dosage levels and from it we have decided that 8,000 r delivered over ten days to point A from radium alone is very near the optimum. We therefore now aim to deliver this dose in all radical treatments of Stage 1 and 2 patients. When x-rays supplement the radium treatment in suitable Stage 3 and 4 cases, the dose at point A from the radium is reduced to 7,000 r, and 3,000 r of x-rays are delivered to point B. The total dose at point A over the four weeks of this treatment is thus of the order of 9,400 r, while point B receives nearly 6,000 r, which is about a lethal dose for squamous-cell carcinoma in four weeks.

In addition to the above information on general tolerance, we can also now make estimates of the tolerance to radiation of specific tissues. Assuming the irradiation to be spread over eight to ten days, the tolerance of the uterine wall would seem to be somewhat over 30,000 r, while that of the vaginal mucosa is between 20,000 and 25,000 r. On the other hand, the rectovaginal septum will tolerate only about 6,000 r, which constitutes a further reason why the irradiated zone should have small thickness in this direction. It is also the reason for our insistence that there be at least 1 cm. of packing behind the ovoids so that these sensitive tissues are pushed away as far as possible from the high dose zone.

Radiation necroses, like accidents, occur in the best regulated departments, though experience should reduce their number. Those occurring in the treatment of carcinoma of the cervix are mainly due to three causes. The first of these is slipped applicators. The uterine applicator may slip out or the vaginal applicators rotate during the packing process so as to lie on the posterior vaginal wall. The result may be local necrosis with rectal ulceration—the "intrinsic rectal reaction" described by

TABLE III: TREATMENT RESULTS: ALL CASES

	No. Treated	Survival at 3 yr.	5 yr.
1934 and 1935	332	33%	26%
1936 and 1937	298	37%	28%
1938 and 1939	307	40%	32%
1940 and 1941	612	42%	35%
1942 and 1943	577	47%	38%
1944	353	50%	

T. F. Todd (2). If radiographs of the pelvis are taken immediately after the insertion, the fault can be detected and the radium removed before the damage is done.

The second cause of necrosis is retroversion of the uterus, which may carry the radium at the fundus very near to the rectum and again produce an intrinsic reaction. Here, also, a radiograph will reveal the fault and, if it is detected at the first insertion, a shorter uterine applicator should be used at the second insertion.

Paracervical high dose is the third, the most important, and most common cause of necrosis, and produces an "extrinsic rectal reaction" (2). The incidence of this type of necrosis can be systematically reduced only by careful correlation of radiation dosage and its effects, leading to better approximation to the optimum dose. It is of interest that this type of necrosis is often accompanied by recurrence, in the so-called, and as yet not satisfactorily explained, supra-lethal effect.

Finally, a few words about the results obtained by this method of treatment. In Table III are listed the survival rates for all cases treated (representing over 95 per cent of the patients seen) from 1934 to 1944. They have been grouped together in two-year periods simply to keep down the size of the table. In this table (in which the three-year survival figures have been included in order to show the results of the more recent work) two reasonably well marked steps of improvement are seen: first, 1938–1939, when the technique that has been described came into full use; second, after 1941, when our present dosage levels were adopted following a period when both higher and lower dosages had been tried.

The survival rates, though the most important, are not the only index of the value of a method and of the improvements resulting from its adoption. The change of incidence of high-dose effects may also be a useful guide. Table IV shows the percentage of patients, treated in four different years, who were reported as having high-dose effects of any kind. The improvement in the more recent figures over those for 1935 and 1938 is striking. It may be significant that the figures for 1938 show very little improvement over those for 1935, even though the new method was in full use in 1938. The point is that, in 1938, we had little experience of dosage at this site, and the reduction in high-dose effects followed later, only when that experience had been gained.

TABLE IV: HIGH-DOSE EFFECTS

	No. Treated	Percentage High-Dose Effects
1935	93	17
1938	124	14
1941	306	5
1943	381	3

To sum up: We do not suggest that the treatment method outlined at the beginning is more than one way of getting the desired dosage distribution. But we do claim that it has important advantages over the Paris method, from which it was developed, the Stockholm, and other methods. These advantages are its simplicity, adaptability and, above all, the fact that it enables an easily predeterminable dose of roentgens to be delivered to any patient. In our opinion, this latter point is of extreme importance, for it is only when dosage is expressed in roentgens or similar unit, and one has got away from purely arbitrary units like milligram-hours that any correlation between tissue tolerance, tumour effects, and treatment can be accurately made. Any real improvement in results depends on such correlation. Although improvement in results followed the introduction of the method in 1938, even greater improvements in survival rates and in freedom from high-dose

effects followed the correlation of dosage and tissue effects and the modification of dosage in the light of this.

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SUMARIO

Distribución de la Dosis y Dosificación en el Carcinoma del Cuello Uterino

La técnica de Manchester para el tratamiento del carcinoma del cuello uterino es un método intracavitario basado en la técnica de París. El radio es dividido entre una hilera de tubos en el útero y dos aplicadores en la vagina, cada uno de éstos lo más adentro posible en cada fórnix lateral. Los aplicadores, tanto vaginales como extrauterinos, vienen en tres tamaños.

Para estipular la dosis en roentgens, se toma un punto (denominado A) 2 cm. a un lado del conducto central del útero y a 2 cm. de distancia de la mucosa del fórnix lateral en el plano del útero. Una tabla suministra los pormenores de la carga de los distintos aplicadores en términos de unidades a fin de obtener una constancia razonable de la dosis en dicho punto, dependiendo, por supuesto, la dosis exacta de la cantidad de radio empleada como "unidad." En 24 horas, la misma es: para 5 mg. de radio 1,000 r, para 6.66 mg. 1,333 r y para 10 mg. 2,000 r.

Para casos de los Períodos 1 y 2, se emplea el radio solo, considerándose una dosis de 8,000 r esparcida en diez días como muy próxima a la óptima. En casos apropiados de los Períodos 3 y 4 la dosis de radio en el punto A se rebaja a 7,000 r, aplicándose 3,000 r en rayos X al punto B, que queda a la misma altura que el A, pero 5 cm. más afuera hacia la pelvis (véase la Fig. 1). El tratamiento combinado abarca cuatro semanas y lleva 9,400 r al punto A y casi 6,000 al B.

El empleo de esta técnica ha mejorado los coeficientes de sobrevivencia y rebajado los efectos contraproducentes de las dosis altas. La ventaja más notable consiste en que permite aplicar a cualquier enferma una dosis fácilmente predeterminable en roentgens. Sólo cuando se expresa la dosis en roentgens o unidades semejantes, más bien que en unidades tan arbitrarias como horas-miligramos, puede establecerse correlación entre la tolerancia histológica, los efectos del tumor y el tratamiento.

DISCUSSION

A. N. Arneson, M.D. (St. Louis, Mo.): To attempt discussion of the physical data given in Dr. Meredith's presentation would be presumptous on my part. From a clinical point of view, however, the end-results of treatment present evidence of the precision that has been gained in technic. We find here a splendid example of research applied to clinical practice. Physical principles were employed for devising a method of treatment that would deliver radiation as uniformly as possible throughout a given volume of tissue. Experimentation at different dose levels was utilized to accumulate data upon tissue tolerance and lethal tumor effects. Combination of those studies has made possible the selection and administration of a predetermined number of roentgens to all patients. It would not appear out of order to admit the satisfaction one may find in his own work upon realizing that certain schemes of treatment derived empirically fit rather well into the principles defined by Dr. Meredith and his associ-

ates. One need only study the recent book upon the Manchester Dosage System edited by Dr. Meredith to find such examples.

Emphasis should be made upon the arrangement of radium that has been described. By designating mg.-strength in units, Dr. Meredith has shown certain ratios between the amount of radium employed in the uterine cavity and in the vagina. The number of units placed within a vaginal ovoid varies with the diameter of the applicator, but total vaginal radium exceeds the amount introduced into the uterus. In every instance the source located within the cervical canal, being more or less centrally situated in relation to all other tubes, is the lowest in strength. Recognition of that ratio is of importance in the prevention of untoward sequelae due to overtreatment in the region of the paracervical triangle.

Other causes for radiation accidents described by Dr. Meredith should also be emphasized. Failure to take into account the effect of retroversion of the uterus will almost invariably result in subsequent difficulties. Displacement of a vaginal source, which may result in the so-called "intrinsic rectal reaction," can be avoided by the use of sponge rubber. That method was first employed in this country by the late Dr. John Murphy of Toledo. An applicator can easily be cut out to fit a lesion in a vagina of any shape or dimensions. The disadvantage rests in the somewhat uncertain distance at which radium is employed, due to compression of the rubber. We have used applicators of that type for a number of years, and record the distance factor for vaginal tubes at the value of 0.5 cm. For that reason the total quantity of radium employed in the vagina is at a lower ratio than that described by Dr. Meredith. As a result, we have not the low incidence of high-dose effects that he has attained.

Dr. Meredith made mention of the use of radium alone in the more favorable cases, and combining x-rays with radium in more advanced lesions. Examples can be found of treatment administered effectively by x-rays alone. I feel certain that there has been no intent to specify a method of treatment, and to apply that construction to Dr. Meredith's presentation would be erroneous. The more important point is that all methods of treatment must be correlated and made to fit the natural history of the tumor in question. Due to the high incidence of lymph node metastases even in the very early cases, we have not felt secure in the omission of roentgen treatment.

In the attempt to obtain a more uniform distribution of radium radiation, it would seem that the greater number of sources used in interstitial treatment might be of value. Dr. Corscaden of New York has shown, however, that wide variation in tissue dose can occur, but in pursuit of those studies he has devised a technic that irradiates the tumor-bearing region more uniformly. The number of gamma roentgens delivered to a point near the pelvic wall is somewhat greater than the number given by Dr. Meredith. The dose at the paracervical triangle is also considerably greater. The Manchester system utilizes radium needles extensively, but I do not believe they have thought interstitial sources to be practical in the treatment of cervical cancer. I hope Dr. Meredith will make some comment upon that question.

In conclusion, I would like to commend Dr. Meredith for the advance he has made in the treatment of cervical cancer by correlating physical principles with clinical trial. The aim of the National Radium Commission to standardize radium sources may have aided that problem. It would be interesting to hear Dr. Meredith's opinion as to whether that standardization has not also acted to improve the general quality of treatment within the sphere of the Commission's influence. It has been a pleasure to hear Dr. Meredith, and an honor to discuss his presentation.

Dr. Meredith (*closing*): May I say before I attempt to answer the points that have been raised that I wish to express my sense of honor at being invited to talk to this Society, and thank you all very much indeed for that invitation and for the extraordinary hospitality and kindness I have received. It has been wonderful.

With regard to Dr. Arneson's point, as to why we didn't take up the interstitial method, I think our therapists generally regarded it as too difficult to get the accurate placing of the needles that we believe is necessary. The Parker-Paterson system will only give you the dosages that you calculate provided you place your radium accurately, and our therapists, rightly or wrongly, decided that this was not possible and that we must therefore adopt some other method.

Comparative Accuracy of the Chassard-Lapiné and Recumbent Positions in Roentgen Measurement of the Pelvic Outlet[1]

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ALLEN (1) IN 1947 OUTLINED a technic of roentgen pelvimetry, one of the advantages of which was said to be accurate measurement of the pelvic outlet. We began to use this method in November 1947, because it seemed to us that it offered some definite advantages over that which we had employed and which previously had been described by one of us (Good, 2).

Essential for measurement of the pelvic outlet is an accurate roentgenographic reproduction of the subpubic arch. To achieve this, Allen (3) had previously recommended the position of Chassard-Lapiné over the more widely used recumbent position. In the method of Chassard-Lapiné the patient straddles a cassette, then bends forward at the hips until the undersurface of the symphysis pubis and the ischial tuberosities are equidistant and horizontal to the film. The x-ray tube is centered perpendicular to the film above, or slightly posterior to, the ischial tuberosities (Fig. 1). For the recumbent position, the patient lies supine on the table and the x-ray tube is angled 33 degrees toward the head in an effort to have the central rays strike the pubic rami perpendicularly.

It has been apparent to us for some time that the reproduction of the subpubic arch as obtained with the patient in the recumbent position is frequently inaccurate. If the central rays are not perpendicular to the plane of the subpubic arch, considerable distortion of the arch and its angle will result. The distortion is exaggerated by the fact that the central rays strike the film at an angle of 33 degrees. In an effort to determine whether the position of Chassard-Lapiné is more accurate, we decided to perform a series of experiments with both positions, including in each series the variations in position which are actually encountered during roentgen pelvimetry.

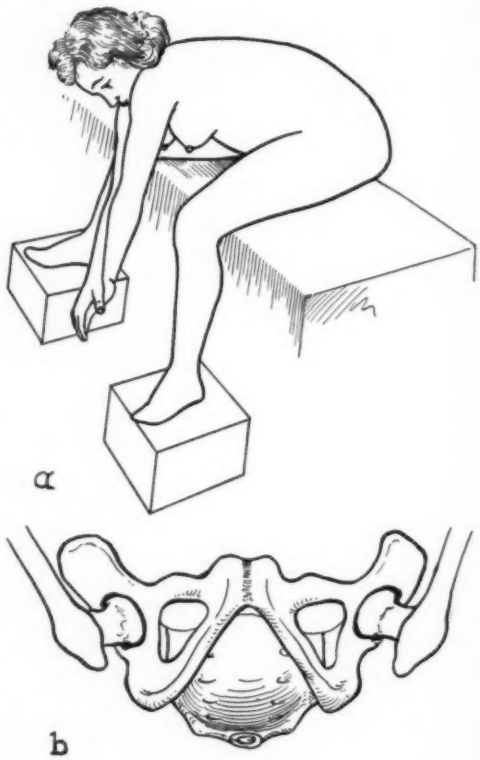

Fig. 1. a. Position taken by patient for roentgenography of the subpubic arch according to the method of Chassard-Lapiné. The central rays are perpendicular to the table top. b. Drawing made from a roentgenogram of the subpubic arch obtained by the method of Chassard-Lapiné.

NATURE OF PRESENT STUDY

We obtained from the Section on Anatomy a disarticulated bony pelvis with sa-

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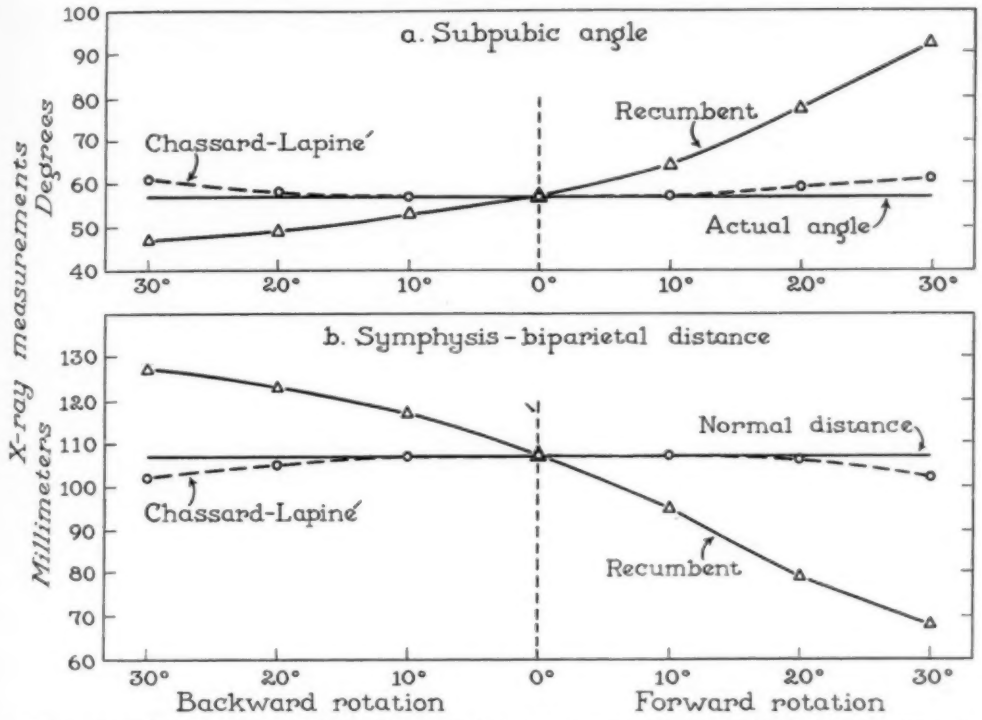

Fig. 2. The effect of forward and backward rotation of the pelvis on the measurement of the subpubic angle (a) and the symphysis-biparietal distance (b) obtained from roentgenograms of the pelvis in the recumbent position and in the position of Chassard-Lapiné.

crum attached, the subpubic angle of which measured 57 degrees. We constructed an adjustable wooden stand to hold the pelvis. By rotating the stand, the pelvis could be rotated forward or backward; it could also be raised or lowered. Multiple roentgenograms were made using both the recumbent position and the position of Chassard-Lapiné under the following conditions: (1) forward-backward rotation of pelvis. (2) variations in the angle of the x-ray tube, and (3) variations in the distance between pelvis and film.

For each roentgenogram of the subpubic arch two measurements were made. First, the subpubic angle was measured by drawing lines from the lower edge of the symphysis tangentially to the inner surface of the tuberosities and measuring the angle thus formed. Secondly, the symphysis-biparietal distance was measured, as described by Allen (1). This measurement comprises one step in Allen's method of computing the pelvic outlet. Briefly, it represents the distance that the greatest (biparietal) diameter of the fetal head must project posterior to the pubic rami in the plane of the outlet during normal labor. It is assumed that the average fetal biparietal diameter at this stage of labor is 100 mm. A semicircle with a base 104 mm. long,[4] drawn on a transparency, is fitted snugly against the subpubic arch, and the distance from the midpoint of the base line to the lower edge of the symphysis is measured. This measurement represents the symphysis-biparietal distance.

ROTATION OF THE PELVIS

Figure 2*a* shows graphically the measurements of the subpubic angle from multiple

[4] The 4 mm. is added to correct for the distortion caused by the distance of the subpubic arch from the film.

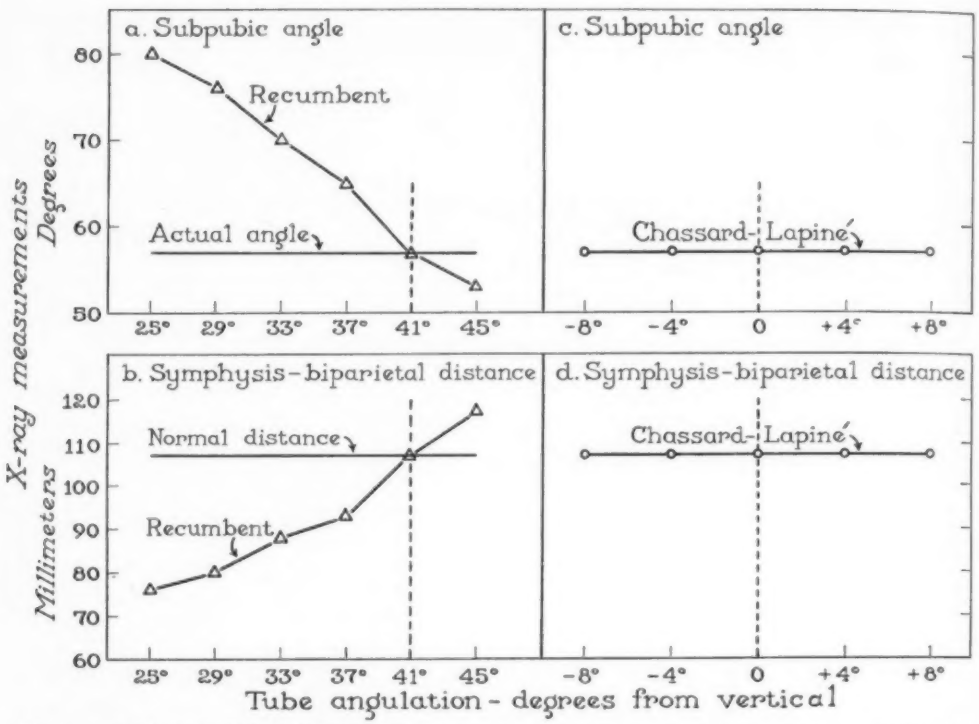

Fig. 3. The effect of variations in the angle of the x-ray tube on the measurement of the subpubic angle (a and c) and the symphysis-biparietal distance (b and d) obtained from roentgenograms of the pelvis in the recumbent position and in the position of Chassard-Lapiné.

roentgenograms exposed during backward and forward rotation of the pelvis in both the recumbent position and the position of Chassard-Lapiné. The actual subpubic angle of the pelvis was 57 degrees. From the pelvic position, which gives a roentgenographic measurement of 57 degrees, backward rotation of the pelvis in the recumbent position through 30 degrees results in a diminution in the projected subpubic angle to 47 degrees, whereas forward rotation of the pelvis by 30 degrees gives an exaggeration of the subpubic angle to 92 degrees. Films were exposed for each 10 degrees of pelvic rotation. Backward rotation in the position of Chassard-Lapiné through 30 degrees produces an increase in the projected subpubic angle of only 4 degrees—from 57 degrees to 61 degrees—whereas a similar amount of forward rotation again produces an increase of 4 degrees in the angle.

Figure 2*b* illustrates graphically the effects of backward-forward rotation of the pelvis, in both positions, on the symphysis-biparietal distance. The normal distance (corresponding to the actual 57-degree subpubic angle) is 107 mm. Backward rotation of the pelvis in the recumbent position through 30 degrees effects an increase in this distance to 127 mm., while an equal amount of forward rotation reduces the distance to 68 mm. In the position of Chassard-Lapiné, backward rotation through 30 degrees produces a diminution of the symphysis-biparietal distance of 5 mm.—from 107 to 102 mm.; forward rotation produces an identical effect.

VARIATIONS IN ANGLE OF TUBE

The second group of roentgenograms of the pelvis was made for each position with variations in the angle of the x-ray tube. For the recumbent position it was found by

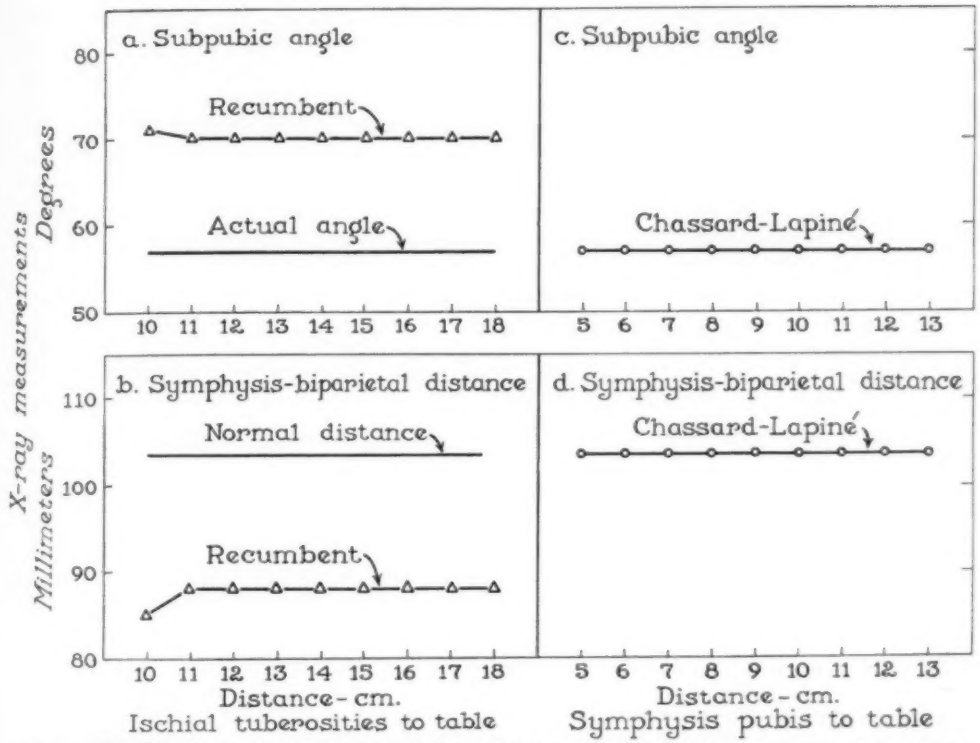

Fig. 4. The effect of variations in the distance of the pelvis from the table on the measurement of the subpubic angle (a and c) and the symphysis-biparietal distance (b and d) obtained from roentgenograms of the pelvis in the recumbent position and in the position of Chassard-Lapiné.

trial and error that a tube angulation of 41 degrees from the vertical produced a subpubic angle of 57 degrees, which is equal to the actual subpubic angle for this pelvis. Figure 3*a* shows that alterations in the tube angulation produce marked distortion in the reproduction of the subpubic angle. For example, with a tube angulation of 37 degrees from the vertical, the roentgenographic measurement of the subpubic angle is 65 degrees, which is 8 degrees greater than the actual angle. Films were exposed for each 4-degree alteration in the angle of the tube. Considerable variation was also effected in the measurements of the symphysis-biparietal distance (Fig. 3*b*).

The results for the position of Chassard-Lapiné are shown in Figure 3*c* and *d*. It will be noted that in this latter position neither the subpubic angle nor the symphysis-biparietal distance was at all affected by variations in the tube angle of 8 degrees in either direction from the vertical.

VARIATIONS IN DISTANCE FROM PELVIS TO FILM

The final series of roentgenograms was made for each position with variations in the distance from pelvis to film. For the recumbent position, with the sacrum almost touching the table top, the distance from the ischial tuberosities to the table measured 10 cm. Therefore, 10 cm. was taken as our shortest distance. Figure 4*a* and *b* illustrates the effects of different pelvis-to-film distances on the projected subpubic angle and symphysis-biparietal distance for the recumbent position. For the range in distances employed, there is only slight variation in either the subpubic angle or the symphysis-biparietal distance. Films were exposed for each 1-cm. variation in distance from pelvis to film.

To obtain the position of Chassard-Lapiné, the pelvis must be tilted forward until the pubic arch is parallel to the film. It is therefore obvious that the pubic arch will be closer to the film with the patient in this position than in the recumbent position. Accordingly, we chose 5 cm. as the shortest symphysis-to-table distance. The results of increasing pelvic distance are recorded in Figure 4*c* and *d*. For the range in distances employed, no variation results in either the subpubic angle or the symphysis-biparietal distance.

SUMMARY AND CONCLUSIONS

A series of experiments was performed to determine the relative accuracy of the recumbent position and the position of Chassard-Lapiné in the roentgen measurement of the pelvic outlet. A disarticulated bony pelvis with attached sacrum was used; it was held in a specially constructed wooden frame which permitted alterations in pelvic position and distance. Multiple roentgenograms of the pelvis were made, with use of each of the two positions under varying conditions of pelvic position, angulation of the x-ray tube, and pelvis-to-film distance, such variables being those commonly encountered in roentgen pelvimetry. For each roentgenogram obtained, measurements of the subpubic angle and the symphysis-biparietal distance were made, and were plotted graphically.

We believe that these experiments offer rather decisive evidence regarding the comparative accuracy of the recumbent position versus the position of Chassard-Lapiné as used in roentgen pelvimetry. It is possible, by use of the recumbent position, to reproduce accurately the subpubic arch by having a specific amount of pelvic tilt or tube angulation or both. With slight variation in either of these factors, however, the subpubic angle undergoes marked distortion on the roentgenogram. Anyone who has done roentgen pelvimetry is aware that it is practically impossible to place different patients in exactly identical positions. Even if this could be accomplished, it would be impossible to know, when the patient is in the recumbent position, just what tube angulation should be employed to project the subpubic arch accurately because of the variation in the shape of the pelvis in different patients.

These sources of error are largely eliminated when the position of Chassard-Lapiné is employed. Our results indicate that within a range of pelvic positions or variations in tube angulation greater than would ordinarily be encountered, the resultant error in reproduction of the subpubic arch is so minimal that it can be discounted. We are convinced, therefore, that the recumbent position as used for roentgen measurement of the subpubic arch and its angle should be discarded in favor of the position of Chassard-Lapiné.

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SUMARIO

Comparativa Exactitud de las Posiciones de Chassard-Lapiné y Recostada en la Medición Roentgenológica del Estrecho Pelviano Inferior

En una serie de experimentos tratóse de determinar la relativa exactitud de la posición reclinada y la posición de Chassard-Lapiné en la medición roentgenológica de la abertura inferior de la pelvis. Una pelvis ósea desarticulada con el sacro unido a la misma fué colocada en una armazón de madera construída *ad hoc*, que permitía

modificar la posición de la pelvis. Tomáronse múltiples radiografías de la pelvis con cada una de las dos posiciones en distintas formas de rotación pelviana, angulación del tubo de rayos X y distancia pelvis-película, o sea los factores variables que se suelen encontrar en la pelvimetría roentgenológica. En cada radiografía obtenida, hiciéronse mediciones del ángulo subpubiano y de la distancia sínfisis-biparietal, marcándose gráficamente las mismas.

Usando la posición recostada, es posible reproducir con exactitud el arco subpubiano, introduciendo cierta inclinación de la pelvis o angulación del tubo, o ambas. Sin embargo, con leve variación en uno u otro factor, el ángulo subpubiano manifiesta desfiguración en la radiografía.

Esas causas de error se eliminan en gran parte al emplear la posición de Chassard-Lapiné. Dentro de una escala de rotación pelviana y de variaciones en la angulación del tubo, superior a la que se encontraría ordinariamente, el error resultante en la reproducción del arco subpubiano fué tan pequeño en dicha posición que puede desatenderse. Los AA. se sienten, pues, convencidos de que la posición recostada, tal como se emplea para la medición roentgenológica del arco subpubiano y del ángulo del mismo, debe ser abandonada en favor de la posición de Chassard-Lapiné.

Thoracopagus Twins: Prenatal Diagnosis[1]

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WHILE THE delivery of conjoined twins is one of the rarities of obstetrical practice, the increasing frequency of routine prenatal roentgen studies makes it imperative that the radiologist recognize this anomaly so that he may forewarn the referring obstetrician of the problem to be faced. In as careful a review of the literature as was possible, though admittedly incomplete, only one case (1) was found in which a roentgen diagnosis of conjoined twins was made before delivery; two additional examples (2, 3) have been discovered through personal correspondence. The following case is presented to call attention to several points which may aid in the prenatal roentgen recognition of this developmental anomaly.

Figs. 1 and 2. Roentgenograms leading to diagnosis of thoracopagus twins.

While the *modus operandi* in the production of Siamese twins is not conclusively known, a number of theories (4, 5) have been advanced, one or the other of which may be the explanation in any given instance. The best known theory, that of the separation of the two blastomeres formed by the first division of the fertilized egg, may well explain identical Siamese twins but certainly cannot account for dissimilar twins. The dizygotic theory, that two separate eggs are fertilized by two separate sperm and then for some reason fuse, is certainly the least acceptable. On a monozygotic basis, it has been suggested that an unfertilized egg may at times divide equally into two, which are then fertilized by separate sperm. Other possibilities are that the nucleus and a large polar body of a single egg may be fertilized by two different sperm, or that an egg may be binucleate, each nucleus being fertilized by a separate sperm. These latter theories could well explain the fact that conjoined twins may be as unlike as any two siblings. It is interesting that in our case one of the

[1] Accepted for publication in February 1949.

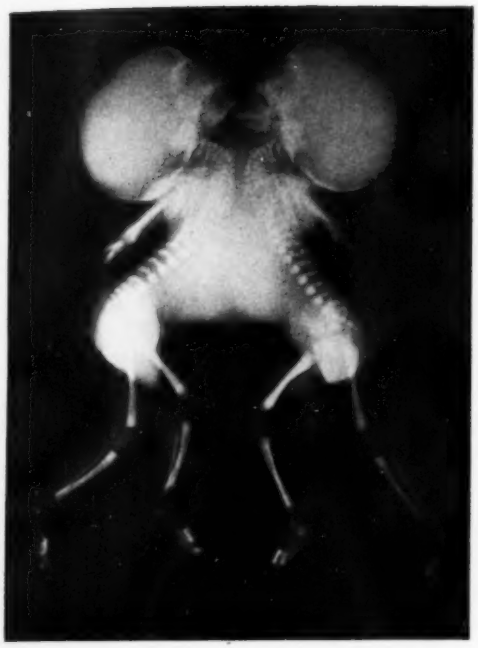

Fig. 3. Postpartum roentgenogram of the conjoined twins.

twins had a cleft palate while the other did not.

A 25-year-old woman had her last menstrual period on Jan. 4, 1948. She had had one previous pregnancy, in 1943, with delivery of a normal 7-lb. infant after a four-hour labor.

The course of the second pregnancy was normal until June 21, when the obstetricians made a diagnosis of polyhydramnios. The uterus was 22 cm. in height on May 31 and 33 cm. in height on July 12. There was beginning edema of the lower extremities on June 21, which progressed to a three-plus generalized edema on July 12. Respiratory distress was evident on about the first of July from the increased intra-abdominal pressure and became rapidly worse until the time of delivery.

Because of the polyhydramnios, the obstetricians suspected some type of fetal abnormality and on July 12 referred the patient for roentgen examination. At this time a presumptive diagnosis of thoracopagus twins was made but because of the rarity of the condition the patient was again examined one week later, July 19. A positive diagnosis was then established.

Several days later the conjoined twins, thoracopagus in type, were delivered by cesarean section. Both expired after delivery, one in about ten, the other in about twenty-five minutes. The time of death was determined by cessation of the individual heart beats.

In studying the films it was seen at once that we were dealing with something unusual. It was apparent that this was a twin pregnancy, with both heads lying high in the fundus. Both, however, were at the same level and in the same coronal plane, a position seldom seen with normal twins. There was also an unusual backward flexion of both cervical spines and, what was felt to be of utmost importance, the space between the lower cervical and upper thoracic spines was much too narrow to allow for the presence of normally developed thoracic cages. The second study was made to determine if, after a week of maternal movement and with manual manipulation at the time of the examination, the relative positions of the fetuses could be changed. They could not, and for this reason the diagnosis was felt to be certain.

SUMMARY

A prenatal diagnosis of thoracopagus twins was made on the following points: (1) Both fetal heads at the same level and in the same plane; (2) an unusual backward flexion of the cervical spines; (3) an extremely narrow space between the lower cervical and upper thoracic spines; (4) no change in the relative positions after maternal movement and manual manipulation.

The recognition of this anomaly is of the utmost importance so that the obstetrician may be warned of the problem with which he will be faced.

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(Para el sumario en español, véase la página siguiente.)

SUMARIO

Gemelos Toracópagos: Diagnóstico Prenatal

En el caso descrito en este trabajo, el diagnóstico prenatal de gemelos toracópagos se basó en los siguientes puntos: (1) Ambas cabezas fetales se hallaban a la misma altura y en el mismo plano; (2) inusitada retroflexión de la porción cervical de las espinas dorsales; (3) estrechísimo espacio entre las porciones cervicoinferior y toracosuperior de los raquis; (4) no haber cambio en las relativas posiciones después de moverse y de haber sido manipulada la madre.

Carcinoma of the Thyroid in Children

A Ten-Year Follow-Up[1]

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THE PURPOSE of this paper is to review 5 cases of thyroid cancer in children followed for more than ten years. These cases were first reported by one of us (1) (H.F.H.) in February 1937. At that time, 6 patients had been studied, 5 of whom were then alive and are still living and well ten years later.

Cancer of the thyroid in children is a rare disease. We have seen a total of 6 histologically proved cases in addition to the 6 cases originally reported. Some of these patients were seen only in consultation and were not treated at the Clinic.

Langmann and Bruch (2) reviewed the literature in 1938 and found a total of 20 cases of cancer of the thyroid in children, to which they added one of their own. Seventeen of these patients were living, the longest survival being nine years after diagnosis and operation. These writers concluded that thyroid cancer in children runs a more benign course than the same condition in adults. This is in accordance with our experience and the observations of others.

Since the article by Langmann and Bruch, few authentic cases have been recorded. Martin (3) observed thyroid cancer in 3 patients, aged nine, fifteen and thirteen years, 2 of whom were still alive one to two years after roentgen and surgical therapy; the third had just begun treatment at the time of the report.

In a review of 774 cases of malignant thyroid lesions, Pemberton (4) found 4 in patients under ten years of age; all 4 patients were girls and the youngest was seven years of age. The series included also 13 patients in the second decade of life, of whom 8 were girls. Thus, 17 patients under twenty years of age constituted 2.2 per cent of the total number of cases.

Williams (5), of the Cardiff Royal Infirmary, reported 2 cases of carcinoma of the thyroid in children fifteen years of age and added 1 case of small-cell sarcoma in a girl of eleven years, who died six months after diagnosis of pulmonary metastases. Scotti (6), among 64 cases of cancer in children, encountered Grade I carcinoma of the thyroid in an 11-year-old boy, who died three days following surgical intervention.

Congenital teratomas should be included in any discussion of malignant disease of the thyroid in children. These lesions are usually recognized in infancy. Sutton and Gibbs (7) reviewed the literature in March 1944 and reported the thirty-first authentic case of congenital teratoma. In the same year Munro and Waldapfel (8) added another case, which was cured by operation.

Hürthle-cell tumors of the thyroid gland have been reported in infants. A review by Morrow (9) indicates that by December 1945, 23 cases of Hürthle-cell tumor had been recorded, 3 of which had been recognized in infants. In these 3 cases the tumor had been regarded as adenomatous, but definite conclusions were unavailable as to whether or not it was malignant.

Kennedy (10), reporting 8 cases of carcinoma of the thyroid gland in children in 1935, estimated that 1 per cent of all thyroid cancers occur under fourteen years of age. He furthermore warned that any mass observed in the thyroid in a child, however innocent it appears clinically,

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Fig. 1. Case 2. Appearance of neck following operation and roentgen treatment in 1930.

should be suspected of having malignant qualities. Pemberton (4), of the Mayo Clinic, stated that palpable benign tumors of the thyroid in children under fourteen years of age are rare, and that of the malignant tumors a great percentage are of the papillary or adenomatous type, of low-grade malignancy, and therefore, in their early stages, amenable to surgical and x-ray therapy. Cattell (11), of this Clinic, reported that in 21,349 thyroid operations there was a total of 487 cancers, an incidence of 2.3 per cent. Eight of the cancer patients were under fourteen years of age, an incidence of 1.6 per cent, a figure slightly higher than those of other authors.

A review of our original 5 cases, followed now for over ten years, is given.

REPORT OF CASES

CASE 1: A boy, 6 years of age, was admitted to the Clinic Feb. 10, 1930, because of a swelling in the midline of the neck of four weeks duration. The swelling was becoming progressively more marked but was not accompanied by constitutional symptoms.

Physical examination was negative except for the mass, approximately 3.5 cm. in diameter, in the neck. A clinical diagnosis of thyroglossal cyst was made, and operation was advised.

On Feb. 12, radical resection of the cyst was performed. While there was no suspicion of malignant disease preoperatively or at operation, the pathologic diagnosis was adenocarcinoma arising in and completely encapsulated in a thyroglossal cyst. In view of this report, fourteen days after the first operation a wider excision was made.

In October 1930, the patient returned for a routine check-up examination and it was found that the cyst had recurred. It was again excised on Oct. 17, and no evidence of carcinoma was discovered. X-ray treatment was advised but refused. A letter three years after operation stated that the boy was in perfect health and had had no trouble with his neck since the operation. He returned to the Clinic in August 1947 for investigation of a chronic urethral discharge. At that time, examination disclosed no evidence of recurrent thyroid tumor.

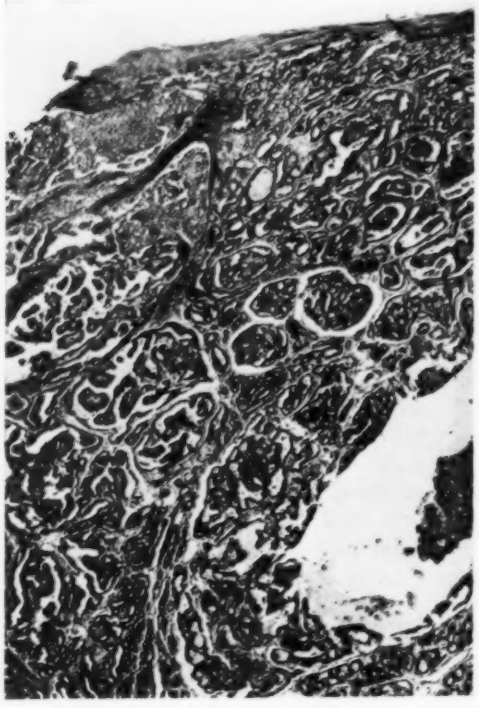

Fig. 2. Case 2. Papillary adenocarcinoma of thyroid.

CASE 2: An 11-year-old girl entered the Clinic on Jan. 25, 1930, complaining of lumps in the neck of one and a half years duration. She had no constitutional symptoms. Nine months before admission a biopsy of one of the nodes revealed normal lymphoid tissue. Again, three months before entry, another node was removed, and a histologic diagnosis of papillary cystadenoma arising in aberrant thyroid tissue was made. X-ray therapy was given, the details of which are not available. The masses in the neck did not disappear entirely (Fig. 1), however, and on Jan. 29, 1930, radical dissection of the right side of the neck was carried out by Dr. Lahey. The pathologic diag-

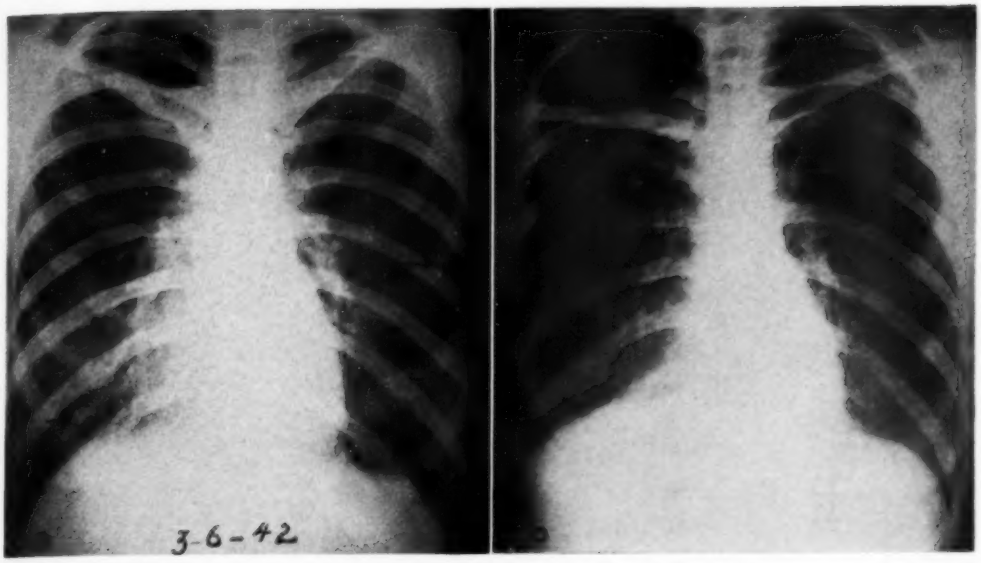

Fig. 3. Case 2. *a*. Roentgenogram of chest March 6, 1942, showing pulmonary metastases. *b*. Roentgenogram of chest May 17, 1948. No metastases visible six years after treatment.

nosis report at that time was papillary adenocarcinoma, Grade II, arising in aberrant thyroid tissue. There was no evidence microscopically of either roentgen reaction or destruction of the tumor cells. Two x-ray treatments were given postoperatively, but again the details are not available. Three years later a small node was palpated near the medial end of the clavicle; the node remained the same size for another three years. In July 1936, however, it was removed surgically. The pathologic report was papillary adenocystoma, malignant.

Further x-ray therapy was advised, and a dose of 1,200 r was delivered to each of two portals measuring 80 sq. cm. There was no evidence of recurrence until January 1938, when a freely movable almond-size node (1.5 × 2 cm.), not previously observed, was palpated on the left side of the trachea. This node was removed on Feb. 3, 1939. The pathologic report was (1) papillary adenocystoma, malignant, with blood vessel invasion; (2) focus of adenocarcinoma (Fig. 2); (3) focus suggesting embryonal adenoma with capsule invasion. There was no evidence of recurrence up to Nov. 28, 1941. However, the child suffered from a slight degree of clinical hypothyroidism; she was tired and listless, but blood cholesterol studies revealed no change. Routine roentgenograms of the chest taken Nov. 28, 1941, showed several rounded nodules, 2 to 5 mm. in diameter, of infiltration in the right lung and two in the left. These nodules persisted and were approximately of the same size on examination on March 6, 1942 (Fig. 3a), at which time the patient was asymptomatic. A total of 1,000 r was administered over both sides of the chest by Dr. E. M. McPeak of Washington, D. C., between March 13, and April 28, 1942. In May 1943, 500 r (in air) was delivered to each of four chest portals for a total dose of 2,000 r. Roentgenograms taken on July 27, 1943, Dec. 20, 1943, and Jan. 3, 1944, all showed progressive regression of the presumed metastatic lesions, and on May 20, 1944, the lungs were essentially clear. There has been no further change in the roentgen appearance of the lung fields to the date of the last examination, May 17, 1948 (Fig. 3b). The patient is well and presents no clinical evidence of disease.

CASE 3: An 8-year-old girl entered the Clinic, Oct. 10, 1935, presenting a hard, smooth, dome-shaped nodule, about 2.5 by 3.0 cm., slightly to the left of the midline of the neck, just above the sternal notch. The nodule had been present and increasing in size for the past year. On Oct. 11, 1935, Dr. R. B. Cattell excised what was presumed to be an adenoma of the thyroid, which involved the isthmus and which was fixed to the trachea. The pathologic diagnosis, however, was adenocarcinoma with blood vessel invasion (Fig. 4).

On Oct. 29, 1935, the patient was referred for x-ray therapy. A series of 33 treatments was given to four portals for a total dose to the skin of 4,640 r. Except for a fairly marked roentgen dermatitis, there was no other evidence of x-ray reaction (Fig. 5). The child remained clinically well and on March 7, when she returned for a check-up four months after the institution of x-ray therapy, a small node was noticed about 3 cm. above the medial end of the left clavicle. One millicurie of radon, screened with 0.3 mm. of gold, was placed in the center of the

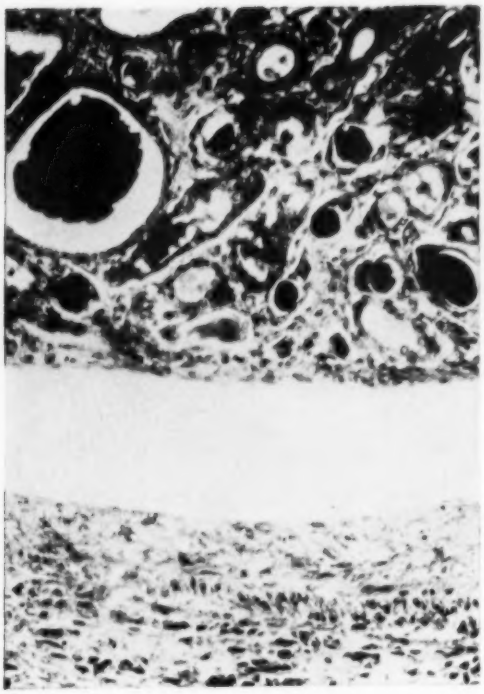

Fig. 4. Case 3. Adenocarcinoma with blood vessel invasion.

Fig. 5. Case 3. Skin changes following irradiation for adenocarcinoma of the thyroid in 1935; 4,640 r in air given in thirty-three days. Central scar resulted from radon gold seed, 1 millicurie, implanted in residual tumor following radiation.

node. It decreased in size and two months later was no longer palpable. In January 1939, reexamination showed a telangiectatic scar from the radon, which had faded somewhat by January 1940.

The patient was well until February 1946, when she came to the clinic complaining of another lump in the left side of the neck, which seemed to be enlarging. A smooth mass, 3 by 4 cm. in diameter, was palpable. In March 1946, a left subtotal hemithyroidectomy was done. The pathologic diagnosis was multiple colloid adenomatous goiter with no evidence of carcinoma. The patient has been well to the present time.

CASE 4: A 13-year-old girl came to the Clinic in October 1935, with a mass in her neck of six months duration. Examination revealed a hard nodule, 4 cm. in diameter, at the left of the midline at the isthmus. On Nov. 5, a left subtotal hemithyroidectomy was carried out. The pathologic report was papillary adenocarcinoma of the thyroid (Fig. 6).

On Nov. 14, the patient was referred for x-ray therapy. She received a total dose of 4,200 r, measured in air, 2,100 r being delivered to each of two portals (Fig. 7).

From this time periodic examinations have shown normal blood cholesterol and no evidence of recurrent thyroid disease. There was a paralysis of the left recurrent laryngeal nerve as a result of the original tumor.

When the patient was seen at the Clinic on June 4, 1946, she had a palpable, slightly tender node on the right side of the thyroid. This mass she had noticed for two months. It was removed on July 18, 1946, and the pathologic report was multiple colloid adenomatous goiter.

At her last visit, in May 1947, the patient had some slight swelling of the right side of the neck, considered to be normal thyroid tissue.

CASE 5: A girl of 9 years entered the Clinic Nov. 26, 1934, because of enlargement of the neck of two months duration. The thyroid was enlarged, firm and fixed, with nodes in front of and behind the sternomastoid muscle. On Nov. 28, the nodes were excised and the pathologic report was "carcinoma simplex, small-cell compact type of lateral aberrant thyroid, with metastases to lymph nodes and with blood vessel invasion." Following operation a series of 16 x-ray treatments was given for a total dose, measured in air, of 4,900 r (Figs. 8 and 9). Considerable roentgen sickness resulted, requiring hospitalization and transfusion.

On Feb. 2, 1935, a small recurrent node was observed in the right side of the neck. In this, 3 millicuries of radon screened through 0.2 mm. of gold was placed on Feb. 9. Again, there was considerable reaction. The nodule decreased in size, however, and gradually disappeared. The girl's voice became low and somewhat husky. In October 1935, a second series of x-ray treatments was given, consisting of 1,500 r to each of two portals. The patient began to gain weight and her subsequent

Fig. 6. Case 4. Papillary adenocarcinoma of the thyroid in a 13-year-old girl.

Fig. 7. Case 4. Skin reaction following irradiation, 4,200 r in sixteen days (2,100 r to each of two ports, 10 cm. round cone).

growth and development appeared normal. In 1938 she presented normal physical findings but roentgen examination of the chest disclosed a finely

Fig. 8. Case 5. Cervical spine of girl aged 16 years, showing degenerative changes following 4,900 r in air to thyroid region.

Fig. 9. Case 5. Skin changes following irradiation of neck for small-cell carcinoma of the thyroid in 1935, 4,900 r in air in sixteen days.

nodular infiltration in both lower lung fields. She had no cough or other symptoms. In August 1943, hoarseness was present and the right true cord was fixed in the midline; the left was normal. Roentgenograms at this time revealed no change in the appearance of the nodular infiltration in the lower lung fields (Fig. 10). Subsequent examinations, on March 23, 1945, and Jan. 30, 1947, showed no evidence of local recurrence, and the presumed metastatic nodules in the lung fields remained stationary in both size and appearance.

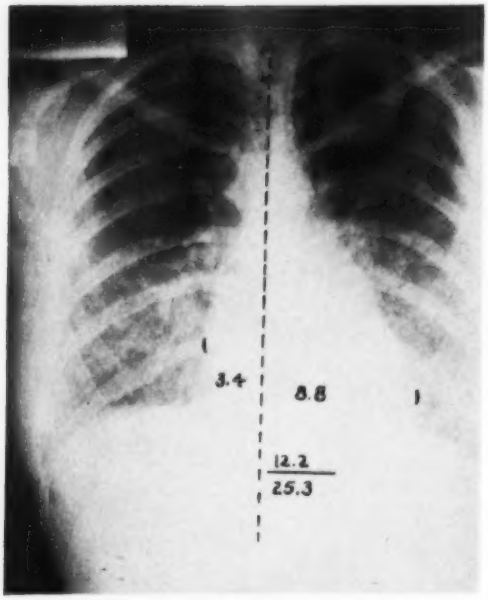

Fig. 10. Case 5. Nodular infiltration of both lung fields, present for five years. Patient is asymptomatic.

COMMENT

These 5 patients with thyroid cancer, whose course has been followed for ten years, have shown a few points in common, the most important being the long survival time, which corresponds to the experience of other writers on this subject. Another interesting and important fact is that pulmonary metastases of a similar appearance developed in 2 of the patients many years after the removal of the primary tumor. The histology of the tumors in these 5 cases shows no startling consistency. In Case 2 there was considerable variation in the type of malignant cell found at different examinations and at different times. In one specimen three malignant cell types were identified. Adenocarcinoma was the most common variety of malignant growth, occurring in some form in 4 of the 5 cases.

The 2 patients with metastases to the lungs had different pathologic pictures. In both cases, however, the cancer had arisen in lateral aberrant thyroid tissue, which may be of some significance. In 2 cases, after the original tumor had apparently been cured, multiple colloid adenomatous goiters developed, possibly on a compensatory basis.

The principal source of argument in a discussion of these cases is in the acceptance of their true malignant character. We believe that the experience of Shields Warren (12) in recognizing several hundred thyroid cancers in several thousand thyroids removed by surgeons of this Clinic should preclude any objection on this score. Certainly, the evidence of distant metastases in 2 cases and local recurrence in another adds weight to the diagnosis of a malignant lesion.

Radiation therapy is indicated as an adjuvant to operation in the treatment of all carcinomas of the thyroid. Our cases illustrate the value of this procedure, since in 3 of the 4 patients in whom irradiation was used there was regression of the recurrent or metastatic lesion.

SUMMARY

Five cases of thyroid carcinoma in children followed for from thirteen to eighteen years have been presented as a supplementary report to an original article published in 1937.

A review of the literature on carcinoma of the thyroid in children has been given.

It is concluded: (1) that any nodular mass in the region of the thyroid in children should be suspected of being malignant until proved benign by excision and biopsy; (2) that x-ray therapy is a most important adjuvant to surgery in the treatment of thyroid cancer; (3) that distant metastases in carcinoma of the thyroid do not necessarily portend an unhappy outcome.

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SUMARIO

Carcinoma del Tiroides en la Infancia: Diez Años de Observación

En 1937, uno de los AA. comunicó 6 casos de carcinoma tiroideo en niños (Hare: Radiology **28:** 131, 1937). Cinco de estos enfermos se encuentran vivos y sanos diez años después, habiendo sido mantenidos en observación por espacio de 13 a 18 años. Todos los casos fueron comprobados patológicamente. Un caso fué tratado exclusivamente por excisión. En los otros 4, la excisión fué complementada con la irradiación. En 2 casos, aparecieron lesiones pulmonares, presuntamente metastáticas, varios años después de la extirpación del tumor primario.

Dedúcese que: (1) en toda tumefacción nodular en la región del tiroides en los niños debe sospecharse malignidad hasta que demuestren su benignidad la excisión y la biopsia; (2) la roentgenoterapia es un importantísimo coadyuvante de la cirugía en el tratamiento del cáncer tiroideo; (3) las metástasis remotas en el carcinoma del tiroides no presagian forzosamente un desenlace infausto.

Roentgen Examination in Acute Thrombosis[1]

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AS IS WELL KNOWN, roentgen examination in acute thrombosis has been based mainly on venography after injection of various opaque media. This latter method has contributed largely to our understanding of the site of origin of the thrombus in the lower extremities. According to Bauer (1) and Hellsten (4), the primary seat of spontaneous thrombosis is in the deep venous trunk of the calf. Here the thrombus has its roots, ascending gradually to the popliteal vein and the veins of the thigh.

The venographic examination gives in most cases clear evidence as to the location of the thrombus and the extent of the secondary circulatory disturbances. Generally, however, the use of this method is limited, mainly because it is expensive and not without complications. Injection of the dye must be made with the greatest care, and every precaution must be taken to prevent the medium entering the tissues outside the vessel, where it may produce local necrosis. In general, injection of contrast medium outside the vessels does not lead to necrosis, but in acute thrombosis of the lower extremities the vascular supply of the tissues is apparently compromised beforehand, so that little more is required to bring about inadequate nutrition of the tissue.

In a previous paper the writer has described a new method of value for the diagnosis of acute thrombosis, based on the roentgen examination of the soft tissues of the extremities (3). Not only is this procedure very easily carried out, but it can be done on the ward with a mobile unit if desirable. Also, it may be repeated without inconvenience to the patient and used to check the result of treatment.

Fig. 1. Accentuation of reticulated subcutaneous structures in acute osteomyelitis.

TECHNIC

The roentgenograms may be taken when the patient is lying in bed, though better pictures are obtained if he is on a Bucky table. The cassette is placed directly under the calf or the thigh, and the exposure is made so "soft" that the skin is definitely outlined. Usually 40 to 50 kv. and 100 ma. are required; the time of exposure is half a second, and the target-film distance 90 to 100 cm. Care must be taken to check the development of the film and keep the darkening strictly within limits. The subcutaneous tissue, which is the most radiolucent part of the extremity,

[1] From the Roentgen Department of Ullevål Hospital, Oslo, Norway (Chief: J. Frimann-Dahl, M.D.). Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Dec. 5–10, 1948.

Fig. 2. Abnormal markings in the flank in acute peritonitis.

Fig. 3. Acute thrombosis: soft-tissue film and venogram made simultaneously to check the findings.

must have a certain clarity on the film. A 30 to 40-cm. cassette is convenient and should be so placed that the lower part of the thigh is included. When a thrombosis in the middle or upper part of the thigh is suspected, a film should be taken right up to the groin. The other extremity should always be filmed for comparison, both sides being exposed simultaneously. It is emphasized that the lateral border must not be covered or cut off. In thin patients perfect films can be obtained without a grid, but for obese patients a movable grid is preferable.

This technic has now been employed in 50 patients with acute thrombosis proved clinically, by venography, or at necropsy. Our experience indicates that the procedure may furnish definite support for the diagnosis.

The method is based upon observations originally made by Laurell (5) in acute osteomyelitis. In that disease changes in the soft tissue may be outstanding at an early stage of inflammation, while the affection of the bone is still rarely visible (Fig. 1). The picture shows accentuation and thickening of the reticulated subcutaneous structures and obliteration of the muscular margins. Findings of this nature are at times observed in the flanks in acute peritonitis (Fig. 2) and in perirenal inflammation, (Skarby, 6).

Frantzell (2) has studied the soft tissue

in edema and made similar observations. In many of our cases a soft-tissue examination and venography have been performed simultaneously. These examinations showed that the abnormal network of subcutaneous markings was due not only to edema but also to dilatation (and hyperemia) of the small subcutaneous vessels. Venography has also been performed to check the diagnosis and to demonstrate the site and size of the thrombus (Fig. 3).

In the majority of cases of acute thrombosis changes are demonstrable in the soft tissue as early as the first or second day after onset of the attack. The drawing reproduced in Figure 4 shows the various

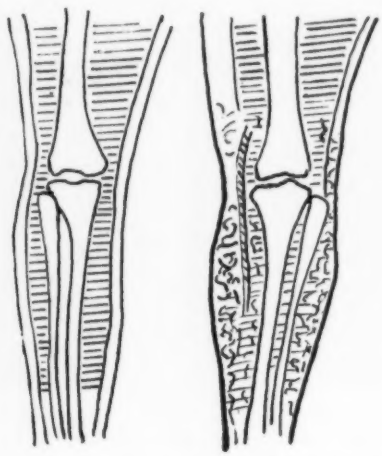

Fig. 4. Schematic drawing to show the changes of the soft tissue in acute thrombosis.

findings. These are: (1) thickening of the cutis-line; (2) accentuation of reticulated subcutaneous structures (caused by edema and dilatation of small vessels); (3) widening of greater vessels, especially the saphenous vein; (4) increased density of muscular shadows and obscuration of their margins; (5) broadening of the extremity.

These signs are more outstanding in patients with abundant subcutaneous fat and are usually more clearly demonstrable in women than in men (Fig. 5). They may be found on the first or second day after onset of the attack and are often best

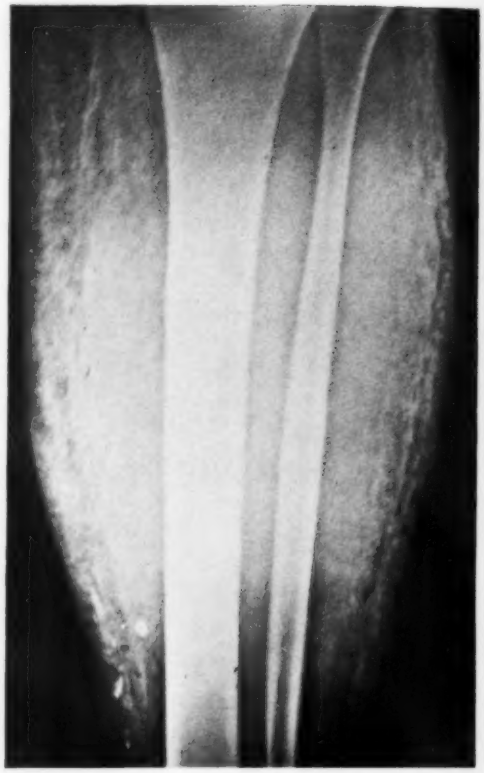

Fig. 5. Reticulated markings in subcutaneous tissue in acute thrombosis.

visualized in the upper part of the leg and on the lateral side (Fig. 6). The findings are at times visible at a stage when the clinical diagnosis is uncertain and consequently may lend support to the latter.

Repeated examination may give confirmatory evidence in doubtful cases, the changes may be followed as the affliction subsides, and the effect of treatment with anticoagulants may be checked.

In some male patients with poorly developed subcutaneous fat and heavy musculature, the findings were so scanty that a definite diagnosis could not be made. The only sign revealed was a broadening of the leg and increased density of the muscular shadow.

In later stages a widening of the saphenous vein is apparent and this vessel may be visualized *without* any contrast medium. This sign is due to occlusion

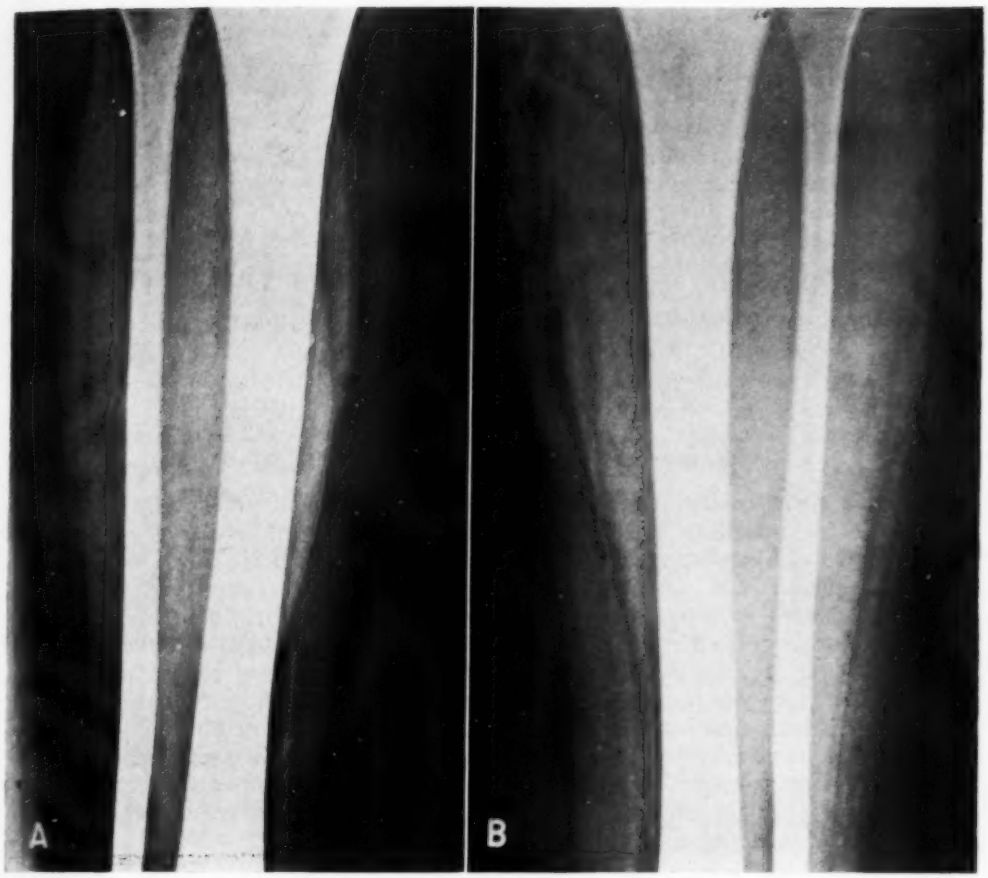

Fig. 6. A. Normal structures of right leg (for comparison). B. Acute thrombosis in the left leg twelve hours after onset of symptoms.

of the deep venous trunk of the calf, so that the main part of the blood stream is forced to pass through the superficial veins, which are consequently widened.

As to the differential diagnosis, many other lesions may display a similar picture. In cardiovascular disturbances, for instance, edema may develop in the lower extremities. This, however, occurs bilaterally and is first seen in the lower part of the leg, above the ankle. In acute thrombosis, on the other hand, the changes in the soft tissue are unilateral; they are likely to be located at the height of the calf and are often better visualized on the lateral than on the medial side. Edema and hyperemia caused by inflammatory lesions have previously been mentioned. In fractures of the leg, edema is commonly seen, and if a complicating thrombosis is suspected, the soft-tissue pictures cannot contribute definitely to the differential diagnosis. In that event, venography must be performed to advance the diagnosis roentgenologically. Finally, it may be mentioned that in our material similar changes in the soft tissue were observed in some cases of thrombosis of the upper extremities, in which the diagnosis was confirmed by venography.

SUMMARY

Roentgen examination of the soft tissue of the extremities may furnish valuable

support for the clinical diagnosis of acute thrombosis. The changes observed are the result of edema and dilatation of the subcutaneous vessels. The examination is easily performed and may be repeated to check results of the treatment without inconvenience to the patient.

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SUMARIO

El Examen Roentgenológico en la Trombosis Aguda

El examen roentgenológico de los tejidos blandos de los miembros puede aportar valioso apoyo al diagnóstico clínico de la trombosis aguda. Las alteraciones observadas consisten en espesamiento de la línea cutánea; acentuación de los tejidos subcutáneos reticulados (debido a edema y dilatación de los vasos pequeños); ensanchamiento de los vasos mayores, en particular de la vena safena; mayor espesor de las imágenes musculares y oscurecimiento de sus bordes; dilatación del miembro.

En la mayoría de los casos las alteraciones del tejido blando ya son observables hasta para el primero o el segundo día después de la iniciación de los sintomas, pudiendo distinguirse en un período en que el diagnóstico clínico es todavía dudoso.

El A. ha ejecutado estudios del tejido blando en 50 casos confirmados clínicamente, o por la venografía o en la autopsia. El procedimiento es sencillo y puede repetirse sin molestia para el enfermo a fin de obtener datos corroborativos o de comprobar el efecto del tratamiento con anticoagulantes.

DISCUSSION

W. Edward Chamberlain, M.D. (Philadelphia, Penna.): It seems to me that I have seen findings something like those described by Dr. Frimann-Dahl when obstruction was to the lymphatics instead of to the veins. I wonder if he would comment on this.

Dr. Frimann-Dahl: One cannot rely completely on the roentgen findings in all cases, but in acute spontaneous thrombosis the changes will be seen in one leg only. Similar observations may be made in cardiac disease with edema of the lower extremities, but bilaterally. In inflammatory lesions with obstruction of the lymphatics this picture is also obtained. However, the clinical examination is usually of aid, so that one would know if an acute thrombosis were to be suspected. I cannot enumerate all the other conditions producing similar findings, but they may be due to chronic processes of various kinds.

John E. Whiteleather, M.D. (Memphis, Tenn.): Dr. Frimann-Dahl has answered most of my questions, but there is one which I should like to ask. Is it possible to tell something about the level of the venous obstruction by soft-tissue radiography?

Dr. Frimann-Dahl: There seems to be distinct evidence as to where these reticulated structures are located in acute thrombosis. They will not, as in cardiac diseases, for instance, be located mainly in the lower parts, but they start at the calf, in the middle of the leg, and are often most pronounced laterally. They may extend to the popliteal area or even up to the groin. Therefore, I think that when the patient is examined early, and two or three subsequent examinations are made, the localization of the soft-tissue changes is rather helpful for the diagnosis.

Roentgen Diagnosis of Ruptured Aneurysm of the Abdominal Aorta[1]

CHARLES E. GRAYSON, M.D., and BAYLES R. KENNEDY, M.D.

RUPTURE OF AN aneurysm of a large vessel is usually a catastrophic event, though Blakemore (2) reports an average duration of life of two to four days following onset of hemorrhage from atherosclerotic aneurysms of the abdominal aorta. Rupture of an abdominal aneurysm may be suspected, but the diagnosis is more frequently established at autopsy. Obviously, aneurysms of thoracic vessels are more easily seen by the radiologist because of the surrounding aerated lungs. For the same reason, rupture of aneurysms of the thoracic aorta or vessels is more rapidly fatal. Aneurysms surrounded by tissues of greater density are less easily recognized, particularly in the absence of gross calcification or displacement of adjacent viscera.

Klinefelter (7), in a paper on the significance of calcification in the roentgen diagnosis of aneurysm, described one case in which the hematoma from a ruptured aneurysm produced a filling defect in the rectum. This was observed at the time of a barium enema study. Morton and Scott (10) report a case of ruptured aneurysm of the abdominal aorta with ureteral displacement.

We have seen 3 cases of ruptured atherosclerotic aneurysm of the abdominal aorta with almost identical roentgen findings. Two important criteria should be mentioned: first, a soft-tissue tumor obliterating the psoas shadow and adjacent retroperitoneal outlines; second, the presence of calcification outlining the aneurysm or the displaced aorta. Since lateral and oblique films of the abdomen are infrequently obtained during routine examination, vertebral erosion, if present, is rarely demonstrated. No erosion of the vertebrae was observed in any of our cases. Our findings are in agreement with those of Blakemore. His series shows that atherosclerotic aneurysms of the abdominal aorta are over three times as frequent as syphilitic aneurysms, that they occur below the renal arteries, that they are fusiform in shape and rarely cause vertebral erosion. Clinical signs and symptoms of ruptured aneurysm of the abdominal aorta are important but of incidental interest, since we are concerned with the roentgenographic appearance. Pain, abdominal tenderness, ileus (6), and fever were present in all 3 cases.

REPORT OF CASES

CASE I: A 52-year-old white male entered the hospital on June 18, 1943, because of continuous pain in the lower back and epigastrium for nine weeks. He had had a hernioplasty ten months earlier. Following the removal of several abscessed teeth, ten weeks prior to admission, aching in the left flank and sharp pains in the abdomen developed. There was a history, also, of nausea and moderate constipation, with a loss of 27 pounds in weight.

The patient had first been seen on June 7. At that time he appeared thin and tired. Generalized abdominal resistance and tenderness were present, but no definite tumor was palpable. The hemoglobin was 72 per cent, Sahli, and the leukocyte count was 12,600. The blood Wassermann antigen reaction was negative. There was a trace of bile pigment and urobilinogen in the urine. Gastro-intestinal examination with barium revealed some dilatation of the small intestine associated with slight stasis.

On admission to the hospital, the patient had no fever. Blood pressure was 144/80. The abdomen was still tense and tender but not distended. The leukocyte count had increased to 20,560, and the hemoglobin had decreased to 58 per cent, Sahli. The following day the temperature rose to 40.2° C., the abdominal pain increased, and psoas spasm was present. Preliminary films were taken for excretory urography, but the examination was not completed because of excess gas in the small bowel and colon. The roentgenograms, however, which were stereoscopic, showed some slight forward displacement of the aorta, identified by minute calcium plaques, and

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Fig. 1. Case I. Hematoma outlined to the left of the lumbar spine, with a small extension to the right behind the aorta. The psoas muscle shadow is obliterated. A minute fleck of calcium indicates the lateral wall of the small aneurysm. The pelvic densities represent phleboliths and remnants of barium in diverticula of the sigmoid colon.

a soft-tissue prominence to the left of the lumbar spine, obliterating a portion of the psoas shadow (Fig. 1). A ruptured abdominal aneurysm was considered primarily. An exploratory incision for suspected abscess was made through the left flank the following morning. Bleeding was profuse and was controlled with difficulty. The patient died about eighteen hours later.

Postmortem examination revealed a ruptured atherosclerotic aneurysm of the abdominal aorta with a hematoma as shown on the roentgenograms. The aneurysm was saccular and about 2 cm. in diameter.

CASE II: A 68-year-old male entered on the emergency service with acute abdominal pain of two or three hours duration and a left inguinal hernia which was particularly tender. Blood pressure was 75/70. A clinical diagnosis of incarcerated hernia was made. Death occurred before further examinations or procedures could be done. A single film of the abdomen was obtained, however, showing the characteristic calcification of a large abdominal aortic aneurysm (Fig. 2). The left psoas and kidney shadow were obliterated by a homogeneous soft-tissue mass in the left abdomen. A diagnosis of ruptured aneurysm of the abdominal aorta with retroperitoneal hematoma was made from the roentgenogram and confirmed postmortem. The aneurysm was atherosclerotic in character.

CASE III: A 77-year-old white male was being followed, with occasional admissions to the hospital. A histologic diagnosis of carcinoma of the prostate had been made elsewhere two months before the first entry, and orchiectomy was done. Serologic tests for syphilis were negative. Periodic roentgen examinations were made for possible bone metastases and particular attention was directed to the fourth lumbar vertebra (Fig. 3). The psoas shadows were normal in a film obtained in March 1946, two months before death. No note was made at that time of the faint calcification outlining the aneurysm of

Fig. 2. Case II. Calcium outlines the large aneurysm of the abdominal aorta. The hematoma extends into the pelvis and up to the thoracolumbar junction, with complete obliteration of the psoas and inferior part of the renal shadows.

the abdominal aorta. The presence of osteitis deformans or a hemangioma in the fourth lumbar body was considered. A pulsating abdominal mass and left inguinal hernia were noted on the hospital entry of March 23, 1945.

On May 27, 1946, the patient was brought to the emergency hospital after six hours of pain "at the site of the inguinal hernia." The pain was of a constant character and increased when the herniation was present. The temperature was 37° C, rising within a few hours to 40° C. Blood pressure was initially unobtainable, but later rallied to 90/60.

Various types of acute accidents were considered, including incarcerated hernia and mesenteric thrombosis. A single film (Fig. 4) of the abdomen showed a large soft-tissue mass on the left side, entirely obliterating the left psoas shadow. The obvious cal-

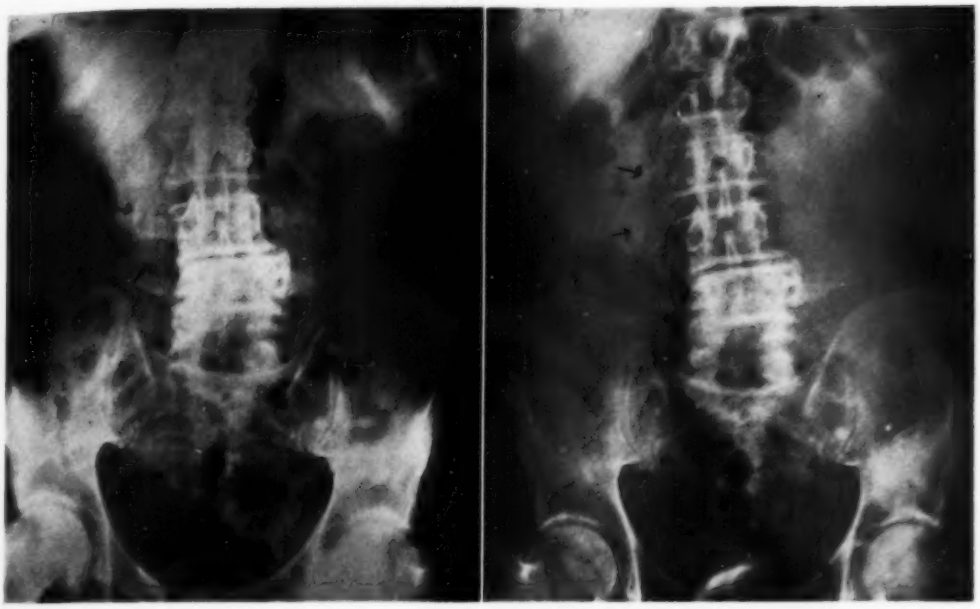

Fig. 3. (left) Case III. Calcium is visible in the abdominal aneurysm only to the right of the lumbar spine. Note the visibility of both psoas shadows.

Fig. 4. (right) Case III. Roentgenogram of the abdomen on the last hospital entry, two months after preceding roentgenogram, showing the same calcification on the right with a large hematoma occupying almost the entire left abdomen and obliterating the left psoas and renal shadows.

cifications of the aneurysm visible on the roentgenograms were noted in retrospect. Death ensued twelve hours later. Postmortem examination revealed a ruptured abdominal aneurysm with a large hematoma in the left retroperitoneal region, extending into the pelvis and into the retroperitoneal tissues of the hernia. Osteitis deformans was found in the fourth lumbar vertebra only. There was carcinoma of the prostate *in situ*, without demonstrable metastasis.

COMMENT

Three cases of ruptured aneurysm presenting almost identical roentgenographic signs are compared. All 3 showed calcification and a left abdominal hematoma obliterating the psoas shadow and, in 2 instances, the renal shadow.

It is admitted that the roentgen demonstration of a ruptured aneurysm is of such relative rarity that it is almost never considered differentially. The diagnosis in the first case was made on the roentgen examination alone. The second case was quite characteristic. Cognizance of the characteristic calcification emphasized by Klinefelter would have made the diagnosis obvious in the third case. All 3 cases were seen by one of the authors and 2 by both.

How important is the recognition of ruptured aneurysm of the abdominal aorta? This depends, obviously, upon the physician's ability to correct the disease. Ruptured aneurysms of the aorta and lesser abdominal arteries have been successfully treated surgically. Dobson *et al.* (3) report 20 per cent survival in operated cases of ruptured aneurysms of the splenic artery. Bigger (1) refers to the first ligation of the abdominal aorta by Sir Astley Cooper, in 1817, and mentions one case of ruptured abdominal aneurysm, in 1899, with a survival of forty-eight days following ligation. Milton's (9) patient, in 1891, lived only one day after ligation for rupture. Matas' (8) patient lived a year, apparently cured, and died of tuberculosis. Elkins (5) states the longest duration of life as three and one-half years. Other reports (11, 12, 13) show variable but

increasing success in prolonging life, though the majority of ligations have been of prophylactic nature. The more recent application of cellophane wrapping (4) offers considerable encouragement in the treatment of abdominal aneurysms.

SUMMARY

Three cases of ruptured atherosclerotic aneurysm of the abdominal aorta are presented. The diagnosis was made, or could have been made, from a single roentgenogram of the abdomen. These cases were similar in that calcifications outlined the aneurysm, partially or completely, and the hematoma occurred in the left abdomen, obliterating the left psoas and adjacent renal shadows.

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SUMARIO

Diagnóstico Radiográfico de Aneurisma Roturado de la Aorta Abdominal

En los tres casos descritos de aneurisma ateroesclerótico roturado de la aorta abdominal, se hizo, o pudo hacerse, el diagnóstico por una sola radiografía del abdomen. Estos casos eran similares en que las calcificaciones demarcaban, parcial o totalmente, el aneurisma, y en que el hematoma quedaba en la porción izquierda del abdomen, obliterando el psoas izquierdo y las adyacentes imágenes renales.

The Diagnosis of Intraspinal Hemangiomas by Myelography[1]

EDWIN C. ERNST, JR., M.D.[2] and NORMAN HEILBRUN, M.D.[3]

MYELOGRAPHY FOR the detection of intradural or extradural lesions of the spinal canal has become a well established procedure. Several recent reports (1, 2, 3, 4) dealing with the new medium, pantopaque, have emphasized the value of the technic particularly for the diagnosis of rupture of the nucleus pulposus with posterior protrusion into the spinal canal and for the demonstration of spinal cord tumors. The usefulness of the procedure in the diagnosis of the less common vascular lesions producing cord compression or nerve root pressure has received less attention.

Hemangiomas give rise to characteristic filling defects in the pantopaque column, permitting a specific diagnosis of a vascular lesion. Such cases have been reported by Epstein and Davidoff (5) and by Bassett (6). Maltby and Pendergrass (4) have seen lateral defects of the central oil column which could not be considered characteristic of a protruded disk, though they pointed out that in such cases the coexistence of disk protrusion or tumor could be ruled out. Camp (7) has stated that the defect due to enlarged blood vessels is easily identified.

In a fairly large experience with myelography, 3 cases exhibiting vascular patterns confirmed surgically were encountered. The myelographic technic used in the study of these cases is similar to that described by Soule, Gross, and Irving (3) and Whitcomb and Wyatt (8).

CASE REPORTS

CASE I: C. T. B., a 45-year-old man, was admitted to the hospital on Aug. 15, 1945, complaining of low back pain radiating down the right leg to the foot. The patient stated that the pain had begun in September 1943, when he fell over a rock. There had been remissions, with recurrences in January and June 1945.

Fig. 1. Case I. Large filling defect in the opaque column. The column above the defect reveals an edematous nerve root sheath.

Examination revealed moderate limitation of motion of the lumbar spine, with slight spasm of the paravertebral muscles. With straight leg raising, point tenderness was noted over the right sacroiliac region. The neurological examination revealed active and equal knee and ankle jerks bilaterally. Vague hypesthesia to pin prick was present over the right heel.

The cerebrospinal fluid, which was clear, contained 2 cells and 225 mg. per cent of protein. Manometric studies were normal.

The plain x-ray examination of the lumbar spine showed no abnormalities. Myelographic examination, however, revealed a persistent filling defect in the region of the upper portion of L-5 (Fig. 1). The defect was characterized by numerous short linear striations of pantopaque irregularly distrib-

[1] Accepted for publication in March 1949.

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[3] Buffalo, N. Y.

Fig. 2. Case II. Persistent defect at T-11 and T-12 on the right. Above the lesion is a tortuous dilated blood vessel.

uted, a picture unlike that seen with a herniated nucleus or tumor. These numerous irregularly placed striations suggested the possibility of the opaque medium passing around vessels. The column above and below the defect was uniform in contour. Above the defect an edematous nerve root sleeve was observed.

At operation a hemangioma was found in the extradural space, compressing the caudal sac and the fifth nerve root. It measured approximately 1.0 cm. in diameter. The dural sac was indented for several millimeters.

CASE II. R. N. A., a 37-year-old man, was well until June 1944, when he began to experience cramps in the muscles of his legs which kept him awake at night. In August 1944, he noticed increasing fatigue and a feeling of constant exhaustion. Because of this, he spent a great deal of time in bed. The muscle cramps disappeared, but there was increasing lack of balance in walking, particularly in the dark. The legs were weak, especially the right, and were controlled with difficulty during walking. Because of these symptoms, the patient was admitted to the hospital for observation.

The physical examination revealed hypalgesia below T-7 on the left and a sharp level between T-7 and T-8. There was loss of position sense in the right toes, and a slight loss on the left. The extensors of the right leg and knee were slightly spastic. The ankle jerks were hyperactive.

The spinal fluid was clear and the manometric reading normal.

Plain x-ray examination of the spine showed a slight scoliosis of the lower dorsal bodies with the convexity to the left. The myelographic examination revealed a persistent filling defect in the area of T-11 to T-12, causing considerable delay in the passage of the opaque medium. Above and below the defect the pantopaque column was of normal width. At the level of the defect, linear vertical striations of pantopaque were seen (Fig. 2). Above this was a dilated blood vessel. This and the striated appearance suggested that one of the components causing the deformity in the column was enlarged vessels.

The canal from T-11 to L-1 was exposed by laminectomy. Upon opening the dura, a large hemangioma was found, extending proximally as far as could be seen. In the region of T-11, the cord showed evidence of degeneration. There was also a large cyst on the dorsal surface of the cord, with a smaller one distal to it. Numerous dilated vessels were seen on the surface of the spinal cord throughout the entire exposed area.

CASE III: R. H. S., a 34-year-old man, first noticed weakness and a dull ache throughout the right leg in February 1945. These symptoms usually appeared after he had been up and about for three or four hours. They were relieved by lying down and flexing the knee. Numbness was also present. The right leg was felt to be more sensitive to changes in the weather and was colder than the left. In June 1945, the patient first discovered that the right leg was smaller than the left. He was admitted to the hospital on Dec. 20, 1945.

The spinal fluid was clear, with normal manometric readings. No cells were found; the proteins were 50 mg. per cent.

Plain films of the cervical spine were normal. Myelographic studies showed no changes in the lumbar or the dorsal spine until the level of D-1 was reached. From here, as far upward as C-2, the canal filled very irregularly, especially between C-4 and C-7. The pantopaque column had a "wormlike" or racemose appearance, suggesting that it was passing around numerous large tortuous vessels. There was some irregular puddling in the region of C-4. The right side of the upper cervical canal was well outlined, but on the left the outline was incomplete (Fig. 3).

A laminectomy was performed, exposing the canal from C-4 to C-7. Upon opening the dura, a large hemangioma was found on the dorsal surface of the cord. It extended above and below the level of exposure. The wound was closed. After healing, the patient received x-ray therapy.

DISCUSSION

The three cases reported above had bizarre neurological findings which were suggestive of disease of the spinal cord associated with nerve root pressure. In one there was a history of trauma prior to the onset of symptoms (Case I); in another there were paresthesias associated with changes in the weather (Case III), a finding reported by Craig and Frugoni (9) in two cases of hemangioma of the cervical cord.

In two patients the proteins in the spinal fluid were increased, though the dynamics and cell counts were normal in all three. With the exception of a slight scoliosis of the lower thoracic spine (Case II), plain x-ray studies revealed no abnormalities. The pedicles showed no changes, and the interpedicular spaces were normal.

In all cases myelography was performed for the purpose of locating more accurately the site of the lesion. In each one, the pattern of the defect in the pantopaque column suggested a vascular component as the cause. These defects revealed themselves as pulsating tortuous shadows of decreased density.

In a series of 559 intraspinal tumors reported by Rasmussen, Kernohan, and Adson (10), 47 cases, or 8.5 per cent, were extramedullary vascular tumors, and 5 cases, or 0.8 per cent, were intramedullary vascular tumors. In a pathologic study of 45 cases of vascular malformations and vascular tumors of the spinal cord, Turner and Kernohan (11) found 18 cases to be malformations and 28 tumor. Venous or arteriovenous angiomas made up the greatest number of the vascular malformations.

In view of this fairly high incidence of vascular lesions among intraspinal tumors, it is surprising that the many reports dealing with myelography have not more often mentioned the specific diagnosis of a vascular cause for some of the defects shown.

CONCLUSION

The value of myelography in the specific diagnosis of intraspinal vascular tumors has been discussed, with reports of three illustrative cases.

Fig. 3. Case III. Extensive defect in the column between C-4 and C-7, with a characteristic tortuous pattern due to vessels.

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SUMARIO

El Diagnóstico de los Hemangiomas Intrarraquídeos por la Mielografía

En los tres casos de hemangioma intrarraquídeo aquí descritos, los extraños hallazgos neurológicos indicaban afección de le médula espinal asociada a compresión de las raíces nerviosas, pero exceptuada una leve escoliosis de la porción torácica inferior de la columna vertebral, los estudios roentgenológicos simples no revelaron anomalías. Ni los pedículos ni los espacios interpediculares mostraban alteraciones.

En todos los casos se ejecutó la mielografía a fin de localizar con mayor exactitud el sitio de la lesión. En todos la forma de la deformación en la columna de pantopaco indicaba como causa un componente vascular. Esas deformaciones tomaban la forma de imágenes tortuosas pulsátiles de menor espesor.

Modified Technic for Cholangiography and Use of a New Contrast Medium (Rayopake) for Visualization of the Biliary Tree[1]

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WHILE NUMEROUS articles have appeared in the literature setting forth the usefulness of cholangiography, the actual technic is described by only a few of the earlier writers. Moreover, the usual procedure as taught to the resident in radiology has certain shortcomings, especially as regards demonstration of the smaller biliary radicles. With the patient recumbent on the fluoroscopic table and the gallbladder under observation on the screen, a contrast medium, preferably water-soluble, is injected through the "T" tube which the surgeon has previously placed in the common duct. This serves to outline the lower portion of the biliary tract quite rapidly and, if there are no abnormalities, the medium will be visualized as it enters the duodenum. The common duct and a few of the larger radicles are usually well delineated, but it is only when there is partial obstruction of the common duct that the medium-sized and smaller hepatic radicles of the biliary tree are demonstrable. To remedy this situation the author has modified the technic in certain details to permit better visualization of the upper portions of the biliary tract.

Various opaque media have been employed for cholangiography. Lipiodol was formerly preferred by many radiologists because of its great radiopacity. In recent years, however, oily preparations have fallen into disfavor because of their failure to mix with bile, and the tendency of the oil to settle out in droplets, leading in some instances to false positive reports. Iodopyracet (diodrast) has had some popularity because of its miscibility with water, but it has the disadvantage of flowing so rapidly out of the common duct that it is necessary for someone to stand next to the patient to make an additional injection while the film is exposed—a requirement involving the danger of overexposure to radiation.

To obtain the advantages of both lipiodol and diodrast—viscosity and water-solubility, respectively—without the disadvantages of these media, the author has made use of rayopake (diethanolamine salt of 2,4-dioxo-3 iodo-6-methyl-tetrahydropyridine-N-acetic acid).[2] This substance, though not previously used for cholangiography so far as could be ascertained, has proved to be quite satisfactory in several cases. No toxic effects have been observed.

TECHNIC

The fluoroscopic table is stripped of the sheet so that the bare skin of the patient's back may be brought into direct contact with the surface of the table. The patient is placed with his head at the foot of the table, resting against a pillow propped against the foot board. Only the lower half of the abdomen and legs are covered with a sheet. The purpose of having the patient's flesh in contact with the table top is to permit adhesion between the body and the table in the exaggerated Trendelenburg position. (This same procedure has been found helpful in performing cervical myelography, though for that purpose the patient lies on the abdomen.) The table can then be tilted to a 30- to 35-degree angle and the patient will not slide along the top. This degree of tilting is greater than can be obtained in the opposite direction with the standard fluoroscopic table.

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[1] From the Baltimore City Hospitals, Baltimore, Md. Accepted for publication in March 1949.

[2] The Rayopake used in this study was supplied by the Hoffman LaRoche Co.

Case I: Diodrast

Case I: Rayopake

Case II: Diodrast

Case II: Rayopake

Figs. 1–4. Cholangiograms obtained with diodrast and with rayopake. Those reproduced in Figs. 1 and 2 were made with diodrast. Those in Figs. 3 and 4, on the same patients, were obtained with rayopake. Note sharper outline of calculi in the common duct in 3 and 4.

With the patient in this position, 10 to 12 c.c. of rayopake is injected directly, under fluoroscopic control, into the "T" tube through a needle puncture. Bile is *not* drawn off. The tube is kept clamped to avoid the possibility of admitting air bubbles, thus eliminating false negative shadows.

During the actual injection, the contrast medium flows by gravity into the hepatic radicles before it fills the common duct and empties into the duodenum. More extensive visualization is thereby obtained than when the patient is kept merely recumbent. The exaggerated Trendelenburg position is maintained while the overhead radiographic tube is angled and centered to the Bucky tray, and the usual number of films taken. The exposures are made rapidly, but too great haste is not required since the medium empties very slowly from the biliary tract. It is not necessary for anyone to remain in the room with the patient while the films are being made, though it is advisable to inject an additional 5 c.c. of medium just prior to exposure. The person performing the injection then moves behind the protective wall of the control booth.

The accompanying figures illustrate the results obtained in 2 cases with diodrast and rayopake. Figures 1 and 2 show cholangiograms made with the patients in the exaggerated Trendelenburg position, with 35 per cent diodrast solution as the contrast medium. The calculi in the common duct are visualized but are less clearly delineated than in Figures 3 and 4. Figures 3 and 4 are cholangiograms on the same patients made with rayopake. The larger radicles are better visualized because of the greater opacity of the medium, and the calculi are more sharply outlined. The finer hepatic radicles in both cases filled more readily with the less viscous diodrast.

SUMMARY

A detailed description of a modified technic for delayed postoperative cholangiography with the patient in the exaggerated Trendelenburg position and with the use of rayopake as the contrast medium is presented.

Rayopake has the advantage of high viscosity and radiopacity; it is water-soluble and miscible; it will not flow rapidly out of the biliary tree, thus obviating the necessity that someone remain in the field of radiation during the course of x-ray exposure to repeat the injection; it outlines non-opaque calculi more sharply than diodrast, though it does not delineate the finer biliary radicles as clearly.

This modified procedure has been used in a number of cases with excellent results and has produced no toxic effects.

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SUMARIO

Técnica Modificada para la Colangiografía y Empleo de un Nuevo Medio de Contraste (Rayopake) para la Visualización del Arbol Biliar

Ofrécese aquí una reseña pormenorizada de una modificación de la técnica para una colangiografía postoperatoria demorada, con el enfermo en una posición de Trendelenburg exagerada y usando "rayopake" como medio de contraste.

El rayopake posee las ventajas de alta viscosidad y radioopacidad, es hidrosoluble y miscible, no abandona rápidamente el árbol biliar, evitando así la necesidad de que alguien permanezca en el campo de irradiación durante el transcurso de la exposición a los rayos X para repetir la inyección; demarca más distintamente que el diodrasto los cálculos no opacos, aunque no delinea tan claramente como aquel las radículas biliares más delicadas.

Este procedimiento modificado ha sido empleado en varios casos con excelente resultado sin producir efectos tóxicos.

Traumatic Pneumocephalus[1]

EARL E. BARTH, M.D., and GEORGE E. IRWIN, JR., M.D.

PRIOR TO THE advent of radiologic diagnosis, only one case of traumatic pneumocephalus had been reported. Extracranial pneumatocele, characterized by the dissection of air through the subaponeurotic tissues of the scalp, has long been recognized, but its intracranial counterpart, following fracture of the paranasal sinuses or mastoids, was not so accessible to the usual methods of diagnosis. Since the report of Luckett in 1913, many cases of pneumocephalus have been recorded, and major contributions such as those of Dandy and Lewis have appeared. The following case presents evidence of the immediate development of pneumocephalus following skull fracture, a somewhat unusual finding.

A well developed white male was attacked by thieves as he stopped to change a tire early in the morning of April 10, 1948. He evidently was struck about the head and face by some blunt object. He was found unconscious on the street shortly after the beating and was brought immediately to Wesley Memorial Hospital. Films of the skull and facial bones taken probably four or five hours after injury were not entirely satisfactory because of the patient's disoriented condition. They revealed, however, various linear fractures in the vault, chiefly on the left, with multiple fracture lines entering the base of the skull in the region of the sphenoid yoke and the cribriform plate. Fracture of the lateral wall of the right maxillary sinus, with dense clouding of this sinus, was also observed. A large amount of air was seen within the subarachnoid space, both in the basal cisterns and surrounding the cerebral convexities. The lateral ventricles were well delineated by air (Fig. 1). Air was also present in the subdural space about the falx (Fig. 2).

Physical examination on entry to the hospital showed edema and ecchymosis of the periorbital tissues. The left pupil was larger than the right, and there was no evidence of light perception by the left eye. A large hematoma was present over the left temporal bone, and there were a few small lacerations, the largest involving the left ear. Dry blood was seen in the nasal cavity, but no cerebrospinal fluid rhinorrhea or otorrhea was observed at this time. There were no cranial nerve motor changes, and generally the reflexes were normal; no signs of meningeal irritation were present. Blood pressure was 130/78. Laboratory findings were not significant.

Fig. 1. April 10, 1948. Multiple fractures of the vault and base are seen. The lateral ventricles are well outlined, the third ventricle to a lesser extent. The basal cisterns are outlined by air.

By April 11 the patient was fully conscious. He received penicillin and sulfonamides from the time of admission to April 18. Parenteral fluids were discontinued after the first two days, after which time he took nourishment by mouth. The blood pressure ranged from 120 to 140 systolic and from 68 to 90 diastolic. The temperature, which rose to 103° F. on April 12, subsided rapidly and remained under 99.4° to the time of discharge. Ophthalmologic examination on April 14 revealed complete blindness of the left eye, and it was concluded that the left optic nerve had been severed. On April 23 repeat roentgenograms indicated that all intracranial air had disappeared (Fig. 3). Films of the orbital areas at that time revealed a fracture involving the left optic foramen which presumably was associated with the left-sided blindness (Fig. 4). The patient was discharged on April 25, asymptomatic except for the unilateral blindness. According to reports, he has remained well since. At no time was there any discharge of cerebrospinal fluid from nose or ears.

Pneumocephalus is most frequently observed following injuries to the skull with fractures extending into the inner wall of the paranasal sinuses or the mastoid cells.

[1] From the Department of Radiology, Wesley Memorial Hospital, and the Department of Radiology, Northwestern University Medical School, Chicago, Ill. Accepted for publication in January 1949.

Fig. 2. April 10, 1948. Roentgenogram showing fracture of wall of right maxillary sinus and subdural air.

Fig. 3. April 23, 1948. Roentgenogram showing complete absorption of air in thirteen-day period.

Fig. 4. April 23, 1948. Roentgenogram showing fracture involving the optic foramen on the left. This fracture was believed responsible for the severance of the left optic nerve.

It has also been reported in association with inflammatory processes and tumors which erode the inner walls of these structures. Gas-forming organisms may produce the phenomenon, but such an occurrence must be rare.

Collections of air in the cranium are of four types depending on the distribution in the intracranial structures. The air may be (1) intracerebral, (2) subdural, (3) subarachnoid, or (4) intraventricular in location. According to Dandy, the intracerebral variety is most common. Each type has certain roentgen characteristics. When the collection of air is intracerebral, one sees a round or oval air shadow projecting backward from the frontal bone within the brain substance. This type of pneumocephalus follows fractures involving the frontal and ethmoid sinuses and usually communicates with these sinuses by a small opening. The subdural collection is commonly elliptical when seen in the lateral film, being delimited by the frontal bone anteriorly and the frontal lobe behind. Subarachnoid air collections usually follow fractures involving the base of the skull, generally the ethmoid and sphenoid cells. The tendency for air to collect within the subarachnoid space is explained by the anatomical extent of the cisternae where they are in contiguity with the ethmoid and sphenoid bones. This type of pneumocephalus produces an appearance

identical with that of the encephalogram. Intraventricular collections are most frequently a late result of the intracerebral type, due to eventual extension of the intracerebral air into a lateral ventricle. Air from a subarachnoid pneumocephalus may also extend into the ventricular system via the foramina of Luschka and Magendie or directly through a tear in the floor of the third ventricle.

Certain anatomical considerations favor the development of intracerebral pneumocephalus in the frontal lobes. Fractures are more common in the frontal region and are likely to involve the paranasal sinuses. In the frontal region the dura is closely adherent to the skull, so that the subdural space is relatively large as compared with the subarachnoid space, which is almost non-existent here. The frontal lobes, furthermore, are in relatively close apposition to the inner table, so that any depression of fragments is likely to cause laceration of the underlying brain. Consequent formation of adhesions at the periphery seals off this lacerated and softened area of brain from the surrounding subdural space. If, then, there is continuity between this area and a paranasal sinus, any increase in the pressure within the latter, as a result of coughing, sneezing, or blowing the nose, tends to force air into the brain substance. The irritative effect of the air in combination with the necrotic nature of the surrounding brain substance leads to enlargement of the cavity. Fluid, cerebrospinal or exudate, escapes from the nose or ear and is replaced by air. If the mechanism producing this air-filled cavity persists unchanged, the cavity continues to increase in size and, as pointed out above, may eventually rupture into the ventricular system. This may be a salutary phenomenon, with eventual absorption of air in a manner similar to that seen after encephalography, and relief of symptoms, which generally are those of meningeal irritation plus those of a space-occupying intracranial lesion. Headache, confusion, stupor, and nuchal rigidity may subside with the occurrence of intraventricular pneumocephalus under these circumstances.

From the foregoing it can be seen that the intracerebral type of pneumocephalus seldom, if ever, develops immediately following an injury. Typically there is a latent period of several days to several months, during which there may or may not be symptoms referable to intracranial disease. This is followed by an explosive onset of severe headache and nuchal rigidity, delirium, or coma, often associated with some act such as sneezing or blowing the nose, after which a large amount of clear fluid drains from the nose. The subarachnoid type is more likely to be seen immediately, and this has been occasionally reported since Teachenor's report of the first case of the kind in 1923.

The presence of cerebrospinal rhinorrhea or otorrhea is the most constant warning sign of the development of pneumocephalus. However, fluid may run into the nasopharynx and be swallowed without its significance being realized. The quantity of fluid lost is of some aid in differentiating the type of pneumocephalus to be anticipated. When there is no communication with the subarachnoid space or the ventricles, only small amounts of fluid will be lost. In these cases the fluid is probably largely exudate. When, however, there is communication between the ventricles or subarachnoid space and the paranasal air spaces, the loss of fluid may be considerable. Appreciable amounts of fluid may be lost when a large porencephalic cyst suddenly establishes communication with the air spaces outside the skull, and this will frequently herald the onset of a perceptible intracerebral pneumocephalus.

In the past, the mortality in cases of pneumocephalus has approximated 50 per cent, whether or not surgical treatment was undertaken. The cause of death in most instances has been a purulent meningitis. With the sulfonamide drugs and antibiotics at our disposal, it should be possible to combat this superimposed infection. Thus, except where persistence of pneu-

mocephalus is demonstrated, it would seem that conservative treatment is indicated.

SUMMARY

1. The diagnosis of pneumocephalus is made roentgenologically.

2. The typical sequence of events suggesting the presence of pneumocephalus is: (*a*) a lesion which opens the inner wall of a cranial air cavity; (*b*) escape of fluid from the neighborhood of the involved bone; (*c*) symptoms of an irritative or space-occupying intracranial lesion; (*d*) x-ray evidence of air in the brain, subdural space, subarachnoid space, or ventricles.

3. A case has been presented in which subarachnoid and intraventricular pneumocephalus was demonstrated immediately following injury.

NOTE: We are indebted to Dr. S. Fogelson for the use of the clinical material contained in this report.

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SUMARIO

Neumocefalia Traumática

El diagnóstico de la neumocefalia se hace roentgenológicamente.

La típica evolución de los hechos que indican la presencia de neumocéfalo es: (a) lesión que penetra la pared interna de una cavidad craneal que contiene aire; (b) escape de líquido de la proximidad del hueso afectado; (c) síntomas propios de una lesión intracraneal irritante o radicada en algún sitio; (d) signos roentgenológicos de la presencia de aire en el cerebro, espacios subdural o subaracnoideo o ventrículos.

Preséntase un caso en el cual se demostró la existencia de neumocefalia subaracnoidea e intraventricular inmediatamente después de fracturas múltiples que afectaban la bóveda y la base del cráneo y la pared lateral del seno maxilar derecho.

An Improved Type of Fluoroscopic Foot-Switch[1]

GEORGE LEVENE, M.D., and ERNEST A. BRAGG, JR., M.D.

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MOST ROENTGENOLOGISTS have experienced the annoyance of working with a foot-switch attached to a long cable. The cable must, of necessity, be long enough to allow using the switch at the foot of the table when the fluoroscope is in the vertical position and at the side of the table when it is horizontal. The roentgenologist must grope for the foot-switch in the dark and push it from one position to another, tripping over the twisted coils on the floor and finally stooping to turn the switch right side up. For many years we have used with greater ease and less annoyance the switch described below.

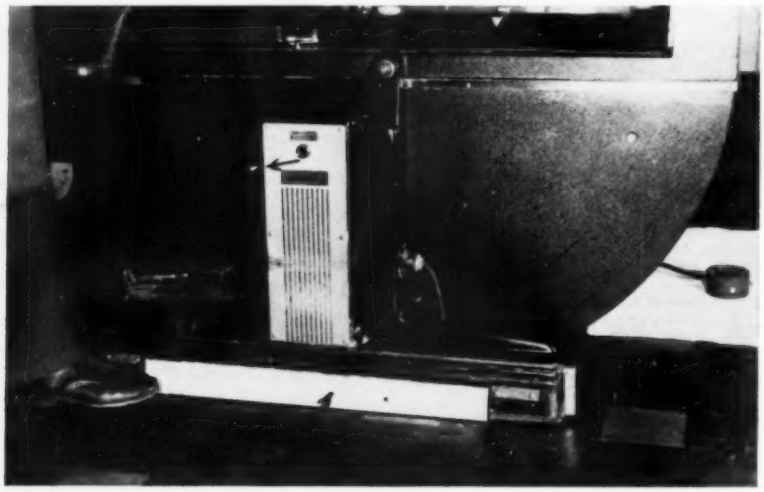

Fig. 1. The switch for vertical fluoroscopy is seen at the right. The long steel-plate foot-switch for horizontal fluoroscopy is indicated by the lower arrow. The slightest pressure of the toe anywhere along the plate energizes the tube. A toggle-switch (upper arrow) breaks the line when not in use.

Two switches are wired in parallel. One of these is attached to a cable 1 foot long and is so positioned as to fall naturally under the right foot of the roentgenologist when he is seated in front of the vertical fluoroscope. The other switch, for horizontal fluoroscopy, is fixed permanently to the base of the table at the side. It consists of a steel plate 28 1/2 inches long, 2 inches wide and 1/4 inch thick, hung from its upper edge so that it is free to swing. The lower edge reaches to within half an inch from the floor. The plate is in contact with the springs of two actuator type micro-switches which are wired in parallel and which are normally open. The roentgenologist energizes the fluoroscopic tube by touching the plate with the tip of his shoe, the movement required being less than a quarter of an inch. He can thus stand with both feet flat on the floor and have the foot-switch in comfortable reach for fluoroscopy over the whole range of travel of the tube. One line to

[1] From the Department of Radiology, Massachusetts Memorial Hospitals and Boston University School of Medicine. Accepted for publication in March 1949.

the foot-switches is interrupted by a toggle-switch located on the pedestal base. This prevents accidental energizing of the fluoroscopic tube.

The length of the foot-switch plate will vary with the type of table in use. In one of our earlier installations, the plate was considerably longer than described above. With most of the modern table bases, the plate can be long enough to eliminate the need for a movable switch on a long cable.

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SUMARIO

Conmutador-Pedal Roentgenoscópico Perfeccionado

En vez del corriente conmutador-pedal para roentgenoscopia, unido a un cable largo, los AA. utilizan dos conmutadores con alambres paralelos. Uno, unido a un cable de 30 cm. de largo, se coloca de modo que quede bajo el pie del radiólogo, al sentarse éste ante el roentgenoscopio vertical. El otro, destinado a la roentgenoscopia horizontal, consiste en una placa de acero fijada permanentemente a la base de la mesa, que no exige más que la más leve compresión por el pie del radiólogo para cargar el tubo fluoroscópico.

EDITORIAL

The Cancer Problem[1]

Presidential Address

The Radiological Society of North America today opens its Thirty-fifth Annual Meeting, dedicating it to lifting a bit higher the veil that hides the mysteries of our number two killer—Cancer.

Here is one of our greatest health problems. It is estimated that 200,000 persons will die from cancer during this current year. Cancer deaths are increasing and will continue to do so unless we make better use of available methods of cancer control or unless some new cure or more certain method of prevention is discovered. There is abundant evidence to show that we are not attaining the results in the control of cancer which are possible with the present knowledge of the disease and the facilities we have for combating it.

Cancer deaths have multiplied tenfold in the first half of this century. Several factors contribute to this, the most important being the increase in population in the age group beyond forty years. It is here that over 85 per cent of cancer occurs. In this group is one-third of our population—more than 50,000,000 persons.

Though no nation-wide registry exists, reliable statistics reveal the rising incidence of cancer. This is substantiated by the Cancer Registry of Connecticut, which has shown the value of accurate cancer records and has revealed important facts useful in planning a logical attack on the disease. There is a need for more such registries throughout the nation. They would help us to a better understanding of our problem.

Through the courtesy of Miss Eleanor J. Macdonald (1), formerly with the Connecticut Registry, I am able to present to you some estimates of the prevalence of cancer in the United States based on the incidence figures in Connecticut. According to Miss Macdonald, there will be approximately 278,000 new cases of cancer in the United States in 1949. Of these, 97,300 or 30 per cent will be cured; 180,700 or 70 per cent will not be cured.

The approximate total number of persons in the United States today with cancer or having a history of cancer is 880,000, of whom some 230,000 have survived five years. The ratio between patients living with cancer and the death rate from cancer in one year is one death for five living patients. On this basis, there should be close to 1,000,000 patients living with cancer in 1949. While these figures are necessarily inexact, they indicate the magnitude of the cancer problem and are a challenge to our efforts at cancer control.

Although the number of cancer deaths is increasing, the death rate per 100,000, for the whole population, is becoming lower, the greatest decrease being in cancer in accessible sites, such as the breast, uterus, mouth, and skin. This is a reflection of the educational program carried on by the American Cancer Society, and others, which has to some extent reduced the delay before treatment. There is still much to be done, however, if we are to make full use of our present knowledge. Delay before treatment is still the greatest hurdle to be overcome.

Studies made to determine the cause of this delay are of interest. In 1938 Pack and Gallo (2) surveyed 1,000 cases, and in 1946

[1] Delivered at the Thirty-fifth Annual Meeting of the Radiological Society of North America, Cleveland, Ohio, Dec. 5, 1949.

a survey was made by Leach and Robbins (3). The figures obtained in these surveys (New York City) are as follows:

Delay Due to	1938	1946	Decrease or Increase
Patient alone	44.3%	32%	12% decrease
Patient and physician	18%	10.8%	8% decrease
Physician alone	17%	27.8%	10% increase
Total delay	80%	70%	10% decrease
No delay	20.7%	29.4%	9% increase

The Philadelphia Committee for Study of Pelvic Cancer was organized in 1945, and a report of their observations was published in 1948. Failure to make a pelvic examination accounted for the delay in diagnosis in at least half of the cases in which the physician was at fault. Howson and Montgomery (4) cite "no examination made" as the cause of delayed diagnosis in 156 of 310 cases in which the patient had sought medical attention within a month after the onset of symptoms but the diagnosis was not established for periods ranging from an average of 7.4 months for cancer of the cervix to 19 months for cancer of the vulva. According to the Philadelphia report, delay was due to:

Patient alone	44%
Patient and physician	12.9%
Physician alone	14.8%
Total delay	71.7%
No delay	28.2%

These studies reveal that the element of delay is present in the diagnosis and treatment of 70 per cent of cases of cancer and that, although in the majority of cases it is the fault of the patient, physicians are responsible to a considerable degree.

It is generally agreed by informed workers in the cancer field that, with full use of our knowledge and facilities and proper cooperation by the patient, the death rate from cancer can be greatly reduced. This can be accomplished without anything new being added to our knowledge of cancer.

EDUCATION PROGRAM FOR THE PUBLIC

As shown by the studies cited above, delay by the patient before treatment is the most important factor in the present death rate of cancer. An adequate educational program is the best way to reduce this delay. The public must be taught that cancer can be cured and the almost universal fear of cancer must be eliminated.

In order to have patients seek treatment for cancer with the least possible delay, they must be made aware of the significant signs and symptoms of the disease, the advantages of early treatment, and the danger of delay. When the public really understands that there is little danger if early cancer is adequately treated, much of the fear will be eliminated, more confidence will exist, and better cooperation will follow.

Until there is some practical way to determine the presence or absence of cancer by a simple test, we must use presently available methods of detection, but these are useless unless the patient decides to be examined. The patient must initiate the process; otherwise we will make little progress in control of the disease.

Courses for the study of cancer should be included in the curriculum early in the school system, not later than high school. Girls' schools and colleges, and all institutions training women, deserve special attention because of the higher incidence of the disease in the female, especially in sites accessible to early diagnosis. Some consideration has been given to this phase of the educational program by national cancer and educational groups, but no adequate plan has been evolved or instituted.

Adult education must be continued with great energy to achieve the possible benefits inherent in the age group over 40, in which such a large proportion of cancer occurs. If this group can be sufficiently and properly informed so as to be alert to the possibilities of cancer in reference to themselves, and will submit to physical examination every year or preferably every six months, the cancer cure rate will increase and the number of deaths will decrease at least 50 per cent.

RESEARCH

Continued research eventually leads to discovery. Although definite progress is being made in cancer control, we are all hopefully waiting for the announcement of the discovery of the cause of neoplastic growth, a method of prevention, an accurate simple method of detection, and a cure. The realization of our hopes depends on the success of research in the many fields of science having a bearing on the origin, growth, and control of cancer.

To aid medical science in the search for the answers to these questions, the American Cancer Society has provided $12,800,000 since 1945 for the national research program which it conducts in cooperation with the National Research Council and leading American scientists. The National Research Council, established by President Wilson during World War I to provide scientific advice to the Federal Government, draws its members from about 85 scientific societies. In 1945 the American Cancer Society contracted with the National Research Council to advise it on how and where public contributions could be used to the best advantage to speed the search for the cause of cancer and aid in the alleviation of this disease. The Council performs this advisory function through the Committee on Growth. This Committee is comprised of twenty distinguished doctors of medicine and the basic sciences, from five general fields of research—biology, chemistry, chemotherapy, clinical investigation, and physics. The Committee in turn is assisted by twenty subcommittees, or panels, with a total membership of 100. The panel members represent such finely focused spheres of study as genetics, viruses, cell chemistry, enzymes, proteins, steroids, endocrine glands, and radioactivity.

Research funds are expended in two major forms: grants-in-aid for projects contributing to the scientific knowledge of normal and malignant growth and fellowships awarded to promising young investigators seeking specialized training in cancer research so as to augment the scientific forces working on the problem. Grants have been made to 81 universities, medical schools, laboratories, clinics, and hospitals, and 48 fellowships have been established in 24 institutions. During the year 1947–48, grant and fellowship applications received by the Committee on Growth represented almost twice as much as the funds available for allocation.

Extensive clinical research is being carried on, especially in the use of sex hormones, chemical compounds, and radioactive isotopes.

The research problem involves thousands of workers and millions of dollars, but in spite of this extensive effort there are not enough investigators and there is not enough money to finance the program adequately. Large sums have been provided by public and private effort, and these funds have increased sharply in the last five years.

Since 1938, the major agencies in the cancer program, including the National Cancer Institute, American Cancer Society, Atomic Energy Commission Cancer Fund, Damon Runyon Memorial Fund, and the Babe Ruth Cancer Fund have provided $141,262,213 for the various phases of cancer control. In addition to this, large sums of money have been provided by other groups and individuals. But although these large sums of money have been provided, more is needed, especially for fellowships in research.

THE DOCTOR'S VITAL PART IN CANCER CONTROL

Unfortunately, experience has shown that in a considerable percentage of cases an adequate examination has not been made by the physician, and existing cancer has not been recognized but has been permitted to go untreated, thus decreasing the chance for cure and increasing the danger of a fatal termination.

To eliminate failure on the part of the physician to recognize cancer and to prevent delay before treatment, we must have an adequate cancer-education program for the physician as well as for the

public. Considerable progress along this line has been made: 75 of the 79 medical schools and 37 of the 41 dental schools in the United States have cancer-teaching programs supported by public funds. Many postgraduate courses and meetings on cancer have been provided throughout the country. About 250 cancer-detection centers have been established. These provide training centers for the profession, as well as aid in cancer detection. The various types of tumor clinics and cancer hospitals all provide centers for training in diagnosis and treatment. Many of the state medical associations have well organized cancer-education programs for their members.

There is no lack of authoritative information on cancer and there are many centers providing practical clinical training in diagnosis and treatment. Therefore, there is no good reason why all physicians should not be well informed on cancer diagnosis and be competent to make or suspect the diagnosis of cancer in most cases.

The individual physician should be sufficiently interested in the problem to avail himself of the information on cancer, but there are some who have no interest and take no part in cancer control. It is the duty of the rest of the medical profession to devise ways and means to encourage the non-interested group to take an active part and to assume their proper share of the responsibility in the cancer control program.

The Hillsdale plan in Michigan, developed through the cooperation of the Hillsdale County Medical Society, the county health authorities, the Cancer Control Committee of the Michigan State Medical Society, and the American Cancer Society, is a practical approach to the problem of cancer education as well as detection. In this plan all physicians are participating and are interested because the plan has not disturbed their practice. Courses of instruction in cancer diagnosis are provided for the doctors. The doctors agree to examine patients for cancer during regular office hours, by appointment, for the usual fee. The American Cancer Society pays for examinations of indigents. A minimum standard type of examination was agreed upon to include a physical examination, with special attention to the usual sites of accessible cancer, skin, breast, cervix, and rectum. In practice the oral cavity and prostate are included. Sixty-three per cent of the cancers discovered were found by this simple standard type of examination. This plan has increased the interest of the doctor in cancer and has demonstrated the value of cancer detection in the office of the physician. It places the responsibility for cancer detection where it should be, in the hands of the physician, especially the general practitioner.

More physicians should have special training in the treatment of cancer and there should be a more efficient geographical distribution of these specially trained men so that they will be more readily available in all areas in the United States. More facilities for the adequate treatment of cancer are also needed throughout the country, especially in the areas away from the large centers of population.

Approximately 300,000 new cases of cancer will occur this year, of which 85 per cent or 265,000 will be in the age group over forty. It is logical to concentrate on the examination of this group in order to discover the greatest number of cancers. It is impossible to examine the entire number in the available detection centers. Some other method must be devised, and the Hillsdale plan is a practical answer.

There are about 165,000 physicians in the United States. With 100,000 of them participating, making two half-hour examinations each day, five days a week, 50 million patients would be examined once in one year, 500 by each physician. Examination every six months in this age group, as recommended by some, could be accomplished by four daily examinations, twenty per week, per physician.

This plan is practical and can be successfully carried out by the cooperation of the public and the physician without interfering with the latter's practice. It will have many beneficial results. The doctors will

become more alert and proficient in the discovery of cancer. More early localized cancer will be found. More patients will receive adequate and proper treatment. More patients will be cured, and the death rate will fall.

Until we have some simple accurate test for the detection of cancer we must depend on the full use of present screening methods. *Physical examination* ranks first among these and will reveal a majority of existing cancers. Sixty-three per cent of the living cancer patients in Hillsdale County, Michigan, found in one year, had cancer of the skin, lip, breast, uterus, prostate, and rectum. *Roentgenologic* examination is very helpful and yields a high percentage of positive diagnoses in cancer of the lung, esophagus, stomach, small intestine, colon, and kidney. The incidence of cancer in these areas is about 30 per cent of all cancer in both sexes. *Cytology* is being used more extensively and successfully for cancer detection in accessible sites. It assumes an important role in cancer of the uterus, prostate, urinary tract, and lung. To quote Dr. Papanicolaou: "It is generally conceded, even by those who are most skeptically inclined, that this method is of unquestionable value in the detection of early or unsuspected cancers of certain organs and is therefore particularly adapted to screening purposes." Competent workers in this method of cancer detection are reporting positive diagnosis in 95 per cent of cancers of the uterus, 81.8 per cent of cancers of the prostate, 90 per cent of cancers of the lung, 50–65 per cent of cancers of the stomach.

For emphasis, I wish to repeat that with proper use of present knowledge and facilities we can reduce the number of cancer deaths and save the lives of at least 100,000 persons a year. The radiologist has an important role in cancer control. He comes in contact with more cancer in the living patient than any of the physicians in the other fields of medicine. We must assume our proper share of the responsibility and be ever on the alert to discover cancer. The program for this meeting was prepared to make us more alert and to aid in the educational program for the medical profession. In closing I would like to emphasize that our greatest opportunity for the successful control of cancer lies in (1) the education of the public, (2) provision of adequate funds for research, (3) education of the physician.

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EDGAR P. MCNAMEE, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

SIXTH INTERNATIONAL CONGRESS OF RADIOLOGY LONDON, 1950

It has been decided to extend until April 1st the date by which offers of papers to be read before the Sixth International Congress of Radiology, in London, must be submitted. Such offers must be accompanied by the abstract and the application for registration as a member of the Congress, and should be sent to the Secretary-General, 45 Lincoln's Inn Fields, London, W. C. 2.

LOS ANGELES RADIOLOGICAL SOCIETY

The newly elected officers of the Los Angeles Radiological Society, which is a Section of the Los Angeles Medical Association, are Dr. Wybren Hiemstra, President; Dr. Joseph Jellen, Vice-President; Dr. Harold Tompkins (658 South Westlake Ave.), Secretary; Dr. John Woodruff, Jr., Treasurer; Dr. Wilbur Bailey, Member of the Executive Committee for two years.

ST. LOUIS ROENTGEN SOCIETY

At the recent Annual Meeting of the St. Louis Roentgen Society, Dr. LeRoy Sante was elected President and Dr. H. R. Senturia (Pasteur Medical Building), Secretary.

UNIVERSITY OF LOUISVILLE

Dr. H. Dabney Kerr is to be at the University of Louisville, Louisville, Ky., as Visiting Professor of Therapeutic Radiology, under the auspices of the Commonwealth Fund, for the week of April 17.

JOSEPH FREEDMAN LECTURES UNIVERSITY OF CINCINNATI

On Saturday and Sunday, April 29 and 30, 1950, Dr. Leo G. Rigler, Professor of Radiology at University of Minnesota School of Medicine, will deliver the second annual Joseph Freedman Lectures on Diagnostic Roentgenology at the University of Cincinnati College of Medicine. Roentgenologists desiring to attend are requested to write Dr. Benjamin Felson, X-Ray Department, Cincinnati General Hospital, for further details.

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

The Special Training Division of the Oak Ridge Institute of Nuclear Studies will conduct the fifteenth, sixteenth, and seventeenth in its series of basic radioisotope technic courses June 5–30, July 3–28, and July 31–Aug. 25. The courses are open to senior research personnel, with priority to university personnel who have difficulty attending courses offered during the winter months.

Thirty-two participants will be accepted for each of the three repeated courses.

Each session includes laboratory work, lectures on laboratory experiments, general background lectures, and special-topic seminars. Experiments cover the use and calibration of instruments and purification and separation procedures, as well as the application of a number of radioisotope technics. Seminars include such discussions as the use of radioisotopes in animal and human experimentation, principles and practices of health-physics, design of radiochemical laboratories, dosimetry, instrumentation, and radiation effects on cells.

A registration fee of $25.00 is charged for the course. Dormitory and hotel facilities are available in Oak Ridge for participants.

Application forms and additional information on the courses may be obtained from Dr. Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

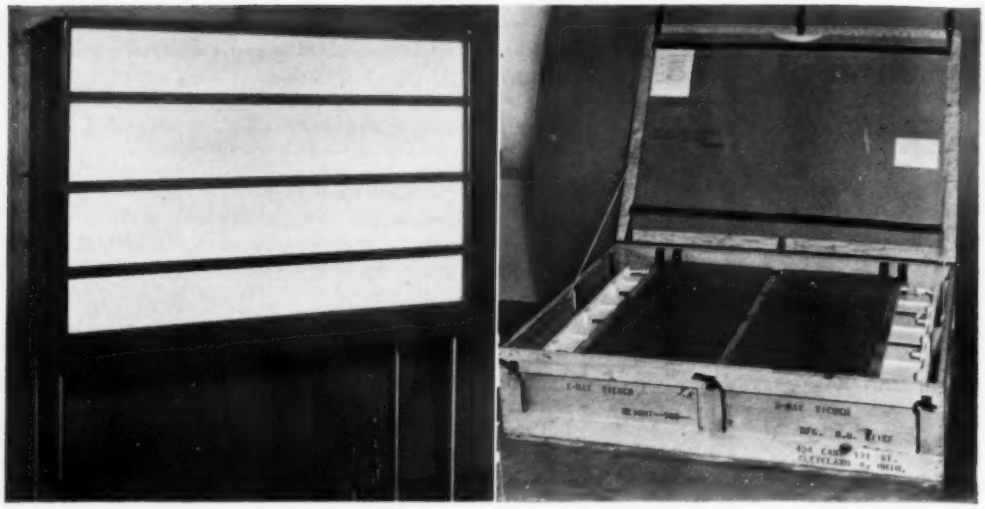
NEW SCIENTIFIC EXHIBIT VIEWING BOXES

At the San Francisco meeting of the Radiological Society of North America, in 1948, the trustees of the Society authorized its View Box Committee to investigate the problem of replacing the old view boxes for scientific exhibits and, if possible, to have a new box ready for a trial showing at the 1949 meetings of the American Roentgen Ray Society and the Radiological Society. It was felt especially desirable to make the showing of exhibits more attractive to men who are not able to compete with some of the larger institutions, which in recent years have shown a tendency to glamorize their exhibits by lavish expenditures. Moreover, the boxes in use had been requiring excessive repairs and the old type of lighting was definitely outmoded.

As a result of the action of the Committee, in cooperation with a similar committee of the American Roentgen Ray Society, the new boxes were shown at the recent annual meetings of the two societies and work on their production in the necessary numbers is now in progress.

Inquiries regarding the private purchase of these boxes are being handled through the office of Dr. Donald Childs, Syracuse, New York, Secretary of the Radiological Society of North America.

The box is of wood and metal construction, with two illuminated surfaces, each 39 1/4 inches high and 59 1/4 inches long. The total height of the assembled unit is 78 inches, length 64 inches, width 24 inches. The box is equipped with V slotted bars to



New view box for scientific exhibits.

accommodate exhibit mounts of various sizes and thicknesses.

Each illuminated side of the box provides space for: 104 lantern slides 3 1/4 × 4 1/4 inches; 60 mounts 5 × 7 inches; 21 mounts 8 × 10 inches; 18 mounts 10 × 12 inches; 8 mounts 14 × 17 inches. Provision is also made for attachment of unit displays utilizing an entire illuminated surface.

The illumination is provided by three fluorescent tubes 5 feet in length, of 100 watts each. Uniform diffusion of the light is secured through the use of 1/8 inch thickness of plastic material on each side of the box.

The box is so constructed that various arrangements of positioning on the exhibit floor may be carried out to conserve floor space and unify various types of exhibits if so desired.

Setting up and dismantling of the box is quickly accomplished without special tools or skilled help. Each box is packed in its own case with compartments for all parts clearly labeled. The weight of the packed case is 365 lb.

The accompanying photographs show (1) the box assembled with one surface exposed for exhibits and (2) dismantled, in its packing case. Each set of boxes will have an additional case of extra fluorescent tubes for replacement and extra V bars for special exhibits.

C. E. HUFFORD, M.D.

Books Received

BRONCHOGRAPHY. By EELCO HUIZINGA, M.D., and G. J. SMELT, M.D., Department of Oto-Rhino-Laryngology, University of Groningen. A volume of 270 pages, with 146 illustrations. Published by Van Gorcum & Co., Ltd., Assen, Netherlands.

PRACTICAL NEURÓLOGICAL DIAGNOSIS, WITH SPECIAL REFERENCE TO THE PROBLEMS OF NEUROSURGERY. By R. GLEN SPURLING, M.D., Clinical Professor of Surgery (Neurosurgery), University of Louisville School of Medicine, Louisville, Ky. A volume of 268 pages, with 101 illustrations. Published by Charles C Thomas, Springfield, Ill., 4th ed., 1940. Price $5.00.

Book Reviews

ESTUDIO RADIOLÓGICO DEL INTESTINO DELGADO. By C. MARINA FIOL, Medical Clinic of the Faculty of Medicine of Madrid and of the Institute of Medical Investigation of Prof. C. Jiménez Diaz. Preface by Prof. C. Jiménez Diaz. A volume of 415 pages, with 514 illustrations. Editorial Paz Montalvo, Madrid, 1949.

Even those who do not read Spanish will find this publication from Madrid on the radiologic study of the small intestine of interest and value because of the numerous illustrations, which are excellent in quality and seem to have lost little in reproduction. Even a moderate knowledge of Latin will enable one to interpret the legends with sufficient accuracy for all practical purposes.

The author discusses the history and technic of radiologic exploration and the radiologic anatomy of the small intestine, though he appears a little confused as to just where the jejunum ends and the ileum begins. He distinguishes primarily the proximal jejunum, the terminal jejunum, the proximal ileum, the pelvic ileum, and finally the terminal ileum. His excellent descriptions of these segments of the small bowel are supplemented by ample illustrative material.

The account of the movement of the small intestine begins with reference to the work of Cannon, covering both his early and late investigations, and includes a careful review of all observations down to the present date. In a study of fifty cases, the author found the cecum beginning to fill within three or three and a half hours in 43 per cent of cases, and by the fourth hour in 80 per cent of cases; in only one case was as long as six hours required.

Though not as much space is given to the disturbances consequent upon vitamin deficiencies as is found in some American works, this new volume may justly be said to cover adequately the radiologic aspects of the small bowel.

DIAGNOSTICA RADIOLOGICA DELL'APPARATO UROPOIETICO. By PROFESSOR L. TURANO, Director of the Institute of Radiology at the University of Florence. A volume of 653 pages, with 659 illustrations. Published by Universo, Viale dell' università, 27, Rome, Italy, 2d ed., 1948.

This volume on the radiology of the urinary tract was written by a radiologist who has enjoyed over twenty years of continuous collaboration with one of the leading urologists in Italy. This work, a comprehensive treatise now in its second edition, is very carefully assembled and lavishly illustrated with radiographs, photographs of specimens, and drawings.

Of special interest is the discussion on the role of hormones in the hydronephrosis of pregnancy. Several helpful hints are found in the chapter on technic. The radiographs of bilharziasis demonstrate very well the calcification occurring in the walls of the ureters and bladder.

Professor Turano has compiled a scholarly book. It is obvious that he has had a wide experience with his subject matter. Clarity of expression and the orderly sequence in which he has arrayed his material make the book an excellent text for Italian radiologists and urologists. It is well printed and carries a complete index.

DIE RÖNTGENBILDANALYSE. EINE RÖNTGENDIAGNOSTISCHE ANLEITUNG FÜR STUDIERENDE UND ÄRZTE. By the late Dr. ERICH SAUPE. Second edition, fully revised by Dr. W. E. BAENSCH, Professor of Radiology, Georgetown University Medical Center and Georgetown University Hospital, Washington, D. C. A volume of 244 pages, with 224 illustrations. Published by Georg Thieme, Stuttgart, 1949.

The author of the original text of this guide to roentgen diagnosis for students and physicians was Dr. Erich Saupe, who died several years ago. In the present edition the book has been fully revised and enlarged by Dr. Baensch. The first section deals with the general principles of radiology, including a discussion of the factors underlying summation, subtraction, and other principles in the interpretation of the various roentgen shadows. Part II concerns pathological appearances involved in the differential diagnosis of disease in all the systems of the body, as, for instance, solitary nodes in the lung fields, miliary types of infiltration, etc. Part III includes advice on how to study radiology, a discussion of the place of radiology in medicine, and finally a section on the organization of an x-ray department.

EXPERIMENTELLE UNTERSUCHUNGEN ÜBER RÖNTGENEFFEKTE UND CHEMISCHE EFFEKTE AUF DIE PFLANZLICHE MITOSE. By DR. KURT HOHL. A monograph of 88 pages, with 30 illustrations and tables. Published by Georg Thieme, Stuttgart, 1949.

This monograph contains the results of studies on the influence of x-rays and chemicals on the mitosis of cells of the onion (*Allium cepa*) and of beans (*Vicia faba*). Doses between 25 and 600 r/air, generated at 180 kv., were employed. The chemicals used were urethane, compounds, dioxan, ethyl alcohol, methyl testosterone, colchicine, chloral hydrate, sublimate, trypaflavine, nitrogen-mustards. The Feulgen stain was used for the determination of the role played by thymonucleic acid in mitosis. Numerous photomicrographs illustrate the observations on pathologic mitoses produced with the above mentioned agents.

The following results were obtained: X-ray doses between 25 and 600 r/air produced pyknosis of chromosomes attributable to concentration in thymonucleic acid content. The same doses produced reduction of motility of centromers and fragmentation of chromonemata. In rare instances doses between 300 and 600 r/air caused disturbance also within the spindle-structure. Doses between 25 and 50 r/air resulted in slowing down of mitotic activity, while with doses between 200 and 600 r/air, cessation of mitotic activity was noticed.

It appeared that chemicals acted on mitosis either on the basis of physico-chemical or merely chemical reactions and that they affected cytoplasm as well as atraktoplasm (spindle substance) and the nucleus. Like x-ray effects they were found to depend on the dosage. Different agents with equal modes of action on the cell produced a summation of effects. While pyknosis of chromosomes was found to be an unspecific effect produced by radiation as well as chemicals, the fragmentation of chromosomes proved to be a specific action of the x-rays. All other pathologic cell changes were found to be unspecific responses to stimulation.

Edward C. Koenig, M.D.

1877–1949

Two weeks after attending the Cleveland meeting of the Radiological Society of North America, Dr. Edward C. Koenig died on Dec. 19, 1949, in the Buffalo General Hospital, where so much of his life had been spent in the practice of radiology. The cause of his death was coronary occlusion.

Edward Koenig was born in Tonawanda, N. Y., May 13, 1877. He was graduated from high school in that city and then attended preparatory school at Ithaca. From there he went to Yale University, and for his medical studies to the University of Buffalo, from which he obtained the M.D. degree in 1904.

Following graduation, Dr. Koenig served his internship at the Buffalo General Hospital, and then returned to his home town of Tonawanda to begin general practice. He took time off from general practice for a year of study in Berlin and Vienna, and again in 1913 went to Berlin for graduate training in roentgenology. He returned to Buffalo in 1914 to become chief roentgenologist at the Buffalo General Hospital, which position he retained until his death.

During World War I, Dr. Koenig volunteered his services and was commissioned a Captain in the Army Medical Corps. He was detailed to the Rockefeller Institute in New York City. On discharge from service, he resumed his work at the Buffalo General Hospital.

In addition to his hospital appointment, Dr. Koenig was Assistant Professor in Roentgenology at the University of Buffalo. He was a member of the Radiological Society of North America; American Roentgen Ray Society; American Medical Association; New York Medical Society; Erie County Medical Society; Buffalo Academy of Medicine; and Buffalo Radiological Society. He was a Fellow of the American College of Radiology and of the American College of Physicians. He was a member, also, of the Buffalo Club; Saturn Club; Tonawanda Lodge, Free and Accepted Masons; Tonawanda Lodge, Royal Arch Masons; Lake Erie Commandery, Knights Templar; Buffalo Consistory; Ismailia Temple of the Shrine.

Edward C. Koenig, M.D.,

Dr. Koenig was, above all, a doctor. To him, patient-physician relationship and understanding were paramount, and he will be remembered for many years by thousands of grateful patients in the Buffalo area. He was extremely helpful and generous to the younger men in the profession, to whom he was ever willing to extend a helping hand. His passing leaves a vacancy in the community and in the profession which will be difficult to fill.

Dr. Koenig is survived by his wife, Ruby H., who resides at the family home in Eden, N. Y., and a son, Edward C. Koenig, Jr., of Haines, Alaska.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Hugh F. Hare, M.D., 605 Commonwealth Ave., Boston 15, Mass.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Philadelphia, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6, Ill.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago 37, Ill.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. D. Anderson, M.D., 420 10th St., Tuscaloosa.

Arizona

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS. *Secretary*, R. Lee Foster, M.D., 507 Professional Bldg., Phoenix.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Harold P. Tompkins, M. D., 658 South Westlake Ave. Meets monthly, second Wednesday, County Society Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, Robert L. Ayers, M.D., 726 4th St., Marysville. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

SAN DIEGO ROENTGEN SOCIETY. *Secretary*, R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Wm. F. Reynolds, M.D., University Hospital, San Francisco 22. Meets third Thursday at 7:45, January to June at Stanford University Hospital, July to December at San Francisco Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Paul E. RePass, M.D., 306 Republic Bldg., Denver 2. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Fred Zaff, M.D., 135 Whitney Ave., New Haven. Meetings bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, Ellwood W. Godfrey, M.D., 1676 Boulevard, W. Hartford. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, Karl C. Corley, M.D., 1835 Eye St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Auditorium.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John J. McGuire, M.D., 1117 N. Palafox, Pensacola. Meets in April and in November.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary*, David Kirsh, M.D., 712 duPont Bldg., Miami 32. Meets monthly, last Wednesday, 8:00 P.M.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wm. W. Bryan, M.D., 490 Peachtree St., N.E. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert Drane, M.D., De Renne Apartments, Savannah. Meets in November and at the annual meeting of State Medical Association.

Illinois

CHICAGO ROENTGEN SOCIETY, *Secretary*, John H. Gilmore, M.D., 720 N. Michigan Ave., Chicago 11. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly as announced.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Harold L. Shinall, M.D., St. Joseph's Hospital, Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*. William M. Loehr, M.D., 712 Hume-Mansur Bldg., Indianapolis 4. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Anthony F. Rossitto, M.D., Wichita Hospital, Wichita. Meets annually with State Medical Society.

Kentucky

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, Everett L. Pirkey, Louisville General Hospital, Louisville 2. Meets second Friday of each month at the Seelbach Hotel.

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary*, J. Howard Franz, M.D., 1127 St. Paul St., Baltimore 2.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, George Belanger, M.D., Harper Hospital, Detroit 1. Meetings first Thursday, October to May, at Wayne County Medical Society club rooms.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS. *Secretary-Treasurer*, R. B. MacDuff, M.D., 220 Genesee Bank Building, Flint 3.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, C. N. Borman, M.D., 802 Medical Arts Bldg., Minneapolis 2. Meets in Spring and Fall.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Wm. M. Kitchen, M.D., 1010 Rialto Building, Kansas City 6, Mo. Meetings last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Charles J. Nolan, M.D., 737 University Club Bldg. Meets on fourth Wednesday, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ralph C. Moore, M.D., Nebraska Methodist Hospital, Omaha 3. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, George Levene, M.D., Massachusetts Memorial Hospitals, Boston. Meets monthly on third Friday at the Harvard Club.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meetings quarterly in Concord.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Benjamin Copleman, M.D., 280 Hobart St., Perth Amboy. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway.

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary*, J. Daversa, M.D., 603 Fourth Ave., Brooklyn. Meets fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meetings January, May, October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening, October to May, at 8:45 P.M., in Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, F. H. Ghiselin, M.D., 111 E. 76 St., New York.

QUEENS ROENTGEN RAY SOCIETY. *Secretary*, Jacob E. Goldstein, M.D., 88-29 163rd St., Jamaica 3. Meets fourth Monday of each month.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, A. Vaughn Winchell, M.D., 40 Meigs St. Meets at Strong Memorial Hospital, last Monday of each month, September through May.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Charles Heilman, M.D., 807 Broadway, Fargo.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Edward C. Elsey, M.D., 927 Carew Tower, Cincinnati 2. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Paul D. Meyer, M.D., Grant Hospital, Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Seneca Hotel, Columbus.

CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, E. C. Elsey, M.D. Meets last Monday, September to May.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Hannan, M.D., Cleveland Clinic, Cleveland 6. Meetings at 6:30 P.M. on fourth Monday, October to April, inclusive.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. E. Brown, M.D., 21st and Xanthus, Tulsa 4. Meets in October, January, and May.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Selma Hyman, M.D., University of Oregon Medical School, Portland. Meets monthly, on the second Wednesday, at 8:00 P.M., in the library of the University of Oregon Medical School.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, George P. Keefer, M.D., 1930 Chestnut St., Philadelphia 9. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Edwin J. Euphrat, M.D., 3500 Fifth Ave., Pittsburgh 13. Meets second Wednesday of each month at 6:30 P.M., October to May, at Webster Hall.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., Lincoln Clinic, Lincoln, Nebr.

South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Marianne Wallis, M.D., 1200 E. Fifth Ave., Mitchell. Meets during Annual Session of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. Meetings second Tuesday of each month at University Center.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frére, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth 2. Meets monthly, third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON X-RAY CLUB. *Secretary*, Curtis H. Burge, M.D., 3020 San Jacinto, Houston 4. Meetings fourth Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting Feb. 3–4, 1950, in Dallas.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., Norfolk General Hospital, Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John H. Walker, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday, October through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Theodore J. Pfeffer, M.D., 839 N. Marshall St., Milwaukee 2. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee. Two-day meeting in May; one-day with State Medical Society, September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursdays 4 P.M., September to May, Service Memorial Institute, Madison 6.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving I. Cowan, M.D., 425 East Wisconsin Ave., Milwaukee 2.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542, Santurce, Puerto Rico.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, E. M. Crawford, M.D. Associate Honorary Secretary-Treasurer, Jean Bouchard, M.D. *Central Office*, 1535 Sherbrooke St., West, Montreal 26, Quebec. Meetings in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origéne Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA. *General Secretary*, Dr. Dionisio Pérez Cosío, Marsella 11, México, D. F. Meetings first Monday of each month.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

On the Growth of the Human Head from Birth to the Third Month of Life. Manuel Higinio Ortiz and Allan Gibson Brodie. Anat. Rec. **103:** 311–333, March 1949.

A report is made of a serial cephalometric roentgen study of the human head from birth until the third month of life. The material consisted of 135 newborn infants, including 5 delivered by cesarean section, on whom x-ray examinations were made at regular intervals, beginning an hour after birth. The heads of cesarean delivered babies revealed that a typal pattern had already been attained *in utero*.

The molding of the normally delivered head was shown to be a matter of a tipping forward of the occipital squama, with the cartilaginous junction at the posterior margin of the foramen magnum acting as a hinge, a bending backward of the halves of the frontal bone, and a squeezing superiorly of the parietal bones. Distortion of the basicranium, as advanced by Moloy, could not be demonstrated. The occipital squama contributed mainly to the recovery of the dolichocephalic head, the frontal squama to that of the brachycephalic. In some cases the parietals sank down and in others maintained their positions. Complete recovery (attainment of a smooth contour) took place by the third day in the majority of cases.

The anterior cranial base (center of sella turcica to nasion) was found to be longer at birth than was the posterior (sella turcica to Bolton point). The distance from sella turcica to Bolton point increased at such a slow rate that it did not lend support to the generally accepted idea that the spheno-occipital junction is an important growth center. In over a third of the samples there was evidence that the sphenoid and presphenoid had not fused at birth, and in some that the *canalis craniopharyngeus* was still patent. These signs disappeared by the end of the third month.

Measurements made on the facial skeleton supported the concept that the plane of interaction between cranial and upper face growth involves the coronal, frontosphenoidal, pterygomaxillary, and zygomaticotemporal sutures, all of which lie in a common frontal plane, and the transverse palatal suture which lies parallel but slightly anterior to it. Measurements between this plane and one parallel to it passing through the sella turcica increase slowly for the first year of life. Studies in older children indicate that it then becomes stable and further forward movement of the facial mask is a result of depositions occurring at the posterior aspect of the facial junctions with this plane.

Something of a similar nature takes place in a vertical direction. Here the main sutures involved are the maxillofrontal and zygomaticomaxillary. The inferior margin of the medial pterygoid plate is at or below the level of the alveolar process at birth. As the facial skeleton is pushed downward by its upward growth against the cranial base, the alveolar process and even the hard palate descend to a lower level than that of the inferior border of the medial pterygoid lamina. All other facial landmarks, such as the inferior orbital point, anterior nasal spine, and all maxillary teeth, are shown to follow parallel downward and forward paths.

Eight illustrations, including one roentgenogram; 2 tables.

Percutaneous Cerebral Angiography and Cerebral Abscess. H. F. Fabritius, A. G. Frøvig, and K. Kristiansen. Arch. Neurol. & Psychiat. **61:** 352–368, April 1949.

Percutaneous cerebral angiography is at present one of the most important aids in the diagnosis of cerebral abscesses and is useful also to detect increase or decrease in size of an abscess following treatment. The method is harmless and permits exact localization of the lesion. Dislocated vessels outlining an avascular or poorly vascularized area without pathologically altered vessels are characteristic of an abscess or cyst.

A chest roentgenogram is essential in any patient suspected of having a cerebral abscess, in an effort to diagnose or exclude a primary pulmonary focus of infection. On plain roentgenograms of the skull, particular attention should be paid to possible displacement of a calcified pineal body. It is also important to search for pathological changes in the temporal bone and in the paranasal sinuses, since sinusitis, mastoiditis, or petrositis may be the forerunner of a brain abscess.

Eight case histories are presented (from the University Clinic in Oslo, Norway). Seven abscesses were supratentorial and one was cerebellar in location. Two were thoracogenic, 3 were otitic in origin, 2 followed sinusitis, and 1 followed a furuncle. Three patients had multiple abscesses. Three, including the 2 with thoracogenic abscesses, died.

The authors used a rather conservative method of treatment. Penicillin was injected, usually intramuscularly and intrathecally, and sulfadiazine was given by mouth. The abscess was then punctured and aspirated, and penicillin was injected into the abscess cavity.

Occasionally air or colloidal thorium dioxide has been injected into an abscess cavity as an aid in determining the size and shape of the cavity.

Seventeen roentgenograms; 2 photographs.

J. R. Hannan, M.D.
Cleveland Clinic Foundation

Tumors of the Acoustic Nerve. Review of 250 Cases by Clinicosurgical Study. Herbert Olivecrona and Alfredo Givré. Prensa méd. argent. **36:** 262–269, Feb. 11, 1949. (In Spanish)

In a series of 3,256 brain tumors which came to operation in the Seraphimer Hospital, Stockholm, there were 296 acoustic neuromas (9 per cent). This incidence closely approximates that reported by Cushing, who found 176 acoustic neuromas among 2,023 verified brain tumors (8.7 per cent). The authors review 250 cases seen between 1930 and 1947.

The age of the patients varied from eighteen to seventy-three years, with an average of forty-five years; the proportion of men to women was 1 to 2. The situation was as often on the right as on the left side. Previous cerebral trauma occurred in 18 cases, with a lapse of a few months to ten years before the appearance of symptoms of tumor.

According to Cushing the appearance of symptoms is as follows: (1) auditory and labyrinth symptoms; (2) pain in the occipital region; (3) cerebral symptoms of incoordination and instability; (4) involvement of cranial nerves; (5) signs of intracranial hypertension; (6) dysarthria, dysphagia, cerebral crisis, and respiratory symptoms. The authors state, however, that this

chronology was not observed in the majority of their patients. The initial symptom in some 60 per cent was related to the eighth nerve. Hypacusia or deafness occurred in 99 cases; buzzing in the ears was the first sign in 34 cases, and vertigo in 15 cases. A full discussion is presented of the symptoms and physical findings and the cerebral manifestations, including the ocular signs, papillary edema and atrophy, narrowing of the visual fields, diplopia, and other nerve changes.

The x-ray examination is done routinely in the dorsosymmetrical, axial, and Stenvers positions. In 189 cases the roentgenograms gave direct information as to alterations of the porus acusticus or the internal auditory canal. Frequently there is atrophy of the sella turcica and of the borders of the occipital foramen. When the clinical diagnosis was doubtful, radiography was done with the aid of contrast material, usually with air, rarely with compounds of iodine. In 26 cases in which ventriculography was done, the diagnosis of tumor of the cerebellopontine angle was made in 23. The typical signs of tumor of the angle consist of elevation of the floor of the third ventricle in the posterior portion; lateral and posterior deviation of the aqueduct; variable degree of obstruction of the aqueduct with dilatation of its proximal portion. The sign described by Carrillo (lateral deviation of the aqueduct shown in postero-anterior projections) was encountered frequently, but elevation of the floor of the third ventricle in the posterior portion was seen only rarely.

Four charts; 3 diagrams. JAMES T. CASE, M.D.
Chicago, Ill.

Tuberous Sclerosis in Three Siblings. Paul W. Miles and Joseph M. Dixon. Arch. Ophth. **41:** 473–480, April 1949.

Tuberous sclerosis in 3 siblings is reported, all of whom had retinal lesions, cerebral calcifications demonstrable roentgenographically, abnormal electroencephalograms, and epileptiform seizures. Two of the children had adenoma sebaceum and other abnormalities of the skin. One child, a 10-year-old girl, had normal mentality, but another, an 8-year-old boy, was retarded mentally. There was no family history of tuberous sclerosis, but the father had an anomaly of the retinas.

Nine illustrations, including 3 roentgenograms.

Rare Diseases of the Frontal Sinuses and Their Diagnosis and Differential Diagnosis by Roentgenograms. L. Psenner. Radiol. clin. **18:** 65–77, March 1949. (In German)

The roentgen appearance of several rare diseases of the frontal sinuses is described: Schüller-Christian disease, syphilis, tuberculosis, cholesteatoma, chondroma, carcinoma, and sarcoma. The findings at times may be characteristic enough for a roentgen diagnosis, but often this cannot be made definitely. It is usually possible to distinguish between benign and malignant tumors. An expanding lesion with sharp borders is most often benign; a destructive lesion without sharp borders is more likely to be malignant. Osteoporosis around the area of destruction may represent rarefaction by tumor tissue or may be caused by tuberculosis. It is not always possible to differentiate an inflammatory lesion from a malignant tumor.

Two roentgenograms. H. W. HEFKE, M.D.
Milwaukee, Wis.

Congenital Hemolytic Jaundice in a Negro Family. J. Churg and M. Rosenbaum. Am. J. M. Sc. **217:** 383–387, April 1948.

Three typical cases of congenital hemolytic jaundice are reported, occurring in a Negro family of 10 persons. In 2 of the patients—the mother and a nine-year-old daughter—the disease was of a fairly severe form, with hemolytic crises and roentgen changes in the skull. The latter were characteristic of the marrow hyperplasia associated with this condition, consisting in thickening of the calvarium and widening of the diploic space. Such changes are a more frequent accompaniment of Cooley's anemia or sickle-cell anemia.

Two roentgenograms; 2 photographs; 1 table.

THE CHEST

An Analysis of Variations of the Segmental Bronchi of the Right Lower Lobe of Fifty Injected Lungs. Franklin R. Smith and Edward A. Boyden. J. Thoracic Surg. **18:** 195–215, April 1949.

An Analysis of Variations of the Segmental Bronchi of the Left Lower Lobe of Fifty Dissected and Ten Injected Lungs. Roger M. Berg, Edward A. Boyden, and Franklin R. Smith. J. Thoracic Surg. **18:** 216–236, April 1949.

These two articles are long detailed descriptions of the gross anatomy of the bronchial tree of the lower lobes of the lungs, and cannot be abstracted satisfactorily. The purpose of the two papers is to establish the prevailing pattern of the bronchi in the lower lobes in a large number of specimens and from this firm ground to analyze the significant and puzzling variations. The authors feel that such a study is a necessary preliminary to accurate localization of lesions of the lung and to surgical resection of its segments. Anyone interested in this detailed and accurate piece of work is advised to read the articles, which are well illustrated in color and black and white. Numerous tables are also included.

A similar study of the right upper lobe, by Boyden and Scannell, appeared earlier (Am. J. Anat. **82:** 27, 1948. Abst. in Radiology **53:** 288, 1949).

HAROLD O. PETERSON, M.D.
University of Minnesota

Bronchographic Anatomy of the Lungs. J. Gordon Scannell. S. Clin. North America **29:** 573–581, April 1949.

The author briefly reviews the anatomy of the lung segments. He believes that when two apical branches are present in the right upper lobe the more anterior of these is an accessory apical branch arising from the anterior segment. This variation occurred in 33 per cent of 50 cases dissected. An "axillary" branch, described in the right upper lobe by some, is considered to be the posterior ramus of the posterior segmental bronchus arising coordinately with the anterior segmental bronchus. Such a variation occurs in less than 25 per cent of cases.

The basic requirement of a satisfactory bronchogram is adequate filling of all the segmental bronchi to the lung division under consideration. Of necessity, normal segments must be just as adequately outlined as diseased areas, since preservation of a segment at operation may depend upon positive bronchographic evidence that it is within normal limits.

Bronchography is usually not indicated in evaluation of lung tumors since the object of prime importance,

identification of the involved lobe, can, in most cases, be determined by fluoroscopy and plain films in varied projections. The introduction of lipiodol tends to confuse the interpretation of parenchymal shadows.

There appears to be general agreement as to disposition and topography of the bronchopulmonary segments but no such agreement exists as to nomenclature. The author prefers the nomenclature of Jackson and Huber (Dis. of Chest **9:** 319, 1943), in which the segments are designated by their position in the respective lobes rather than by their relation to adjacent mediastinal or parietal structures as found in the Brock nomenclature (Anatomy of the Bronchial Tree, London, Oxford University Press, 1946).

The author presents, by way of summary, the following outline of bronchopulmonary segments (Brock's terminology is included in parentheses and the segments are numbered according to the system suggested by Boyden):

Right Upper Lobe
1. Apical (apical)
2. Anterior (pectoral)
3. Posterior (subapical)

Right Middle Lobe
4. Lateral (lateral)
5. Medial (medial)

Right Lower Lobe
6. Superior (apical)
7. Medial basal (cardiac)
8. Anterior basal (anterior basal)
9. Lateral basal (middle basal)
10. Posterior basal (posterior basal)

Left Upper Lobe
1.+ 3. Apical-posterior (apical-subapical)
2. Anterior (pectoral)
4. Superior lingular
5. Inferior lingular

Left Lower Lobe
6. Superior (apical)
7. + 8. Anteromedial basal (anterior basal)
9. Lateral basal (middle basal)
10. Posterior basal (posterior basal)

Two roentgenograms; 4 drawings.

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Value of the Lateral View in Tomography of the Thorax. P. Chatton, A. Maléki, and H. Johannsen. J. de radiol. et d'électrol. **30:** 143–147, 1949. (In French)

Theoretical discussion and concrete examples are cited to show the value of thoracic tomograms taken in the lateral projection. The procedure is useful in the following instances: (1) for the detection of parenchymal retrohepatic and retrocardiac lesions or small tumors and adenopathies of the mediastinum; (2) to aid in demonstrating morphology, *e.g.*, cavitation, etc.; (3) for more exact localization; (4) to obtain complementary information to aid in interpreting pathogenesis and etiology or, in other words, to depict pleural, parenchymal, bronchial, or vascular changes not ordinarily seen in usual views, that may clarify the etiology and development of certain diseases.

Eight tomograms; 3 drawings.

CHARLES NICE, M.D.
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Photographs at Different Points of Time and in Inspiration and Expiration. Eelco Huizinga. Acta oto-laryng. **37:** 131–137, April 1949.

Bronchograms should be taken at intervals to follow the course of a respiratory disease. It is important also that films be obtained both on inspiration and expiration. By this means two types of bronchiectasis may be distinguished. In one the bronchial walls are weak, with changes in the lumen, during respiration, greater than normal; in the second, due to a process of shrinkage in the lung, the pulmonary tissue and bronchial walls form one stiff mass and changes in the lumen are smaller than normal. The first type may be reversible, the second is not.

Two cases of reversible and one of progressive bronchiectasis are reported, with serial bronchograms in each instance.

Bronchography. The Methods by Which It May Be Performed and the Factors Influencing the Choice of Method. Anthony A. Vickers. Brit. J. Radiol. Pt. I. **22:**137–151, March 1949. Pt. II. **22:** 224–233, April 1949.

The choice of method for the performance of bronchography is somewhat influenced by the fate of the iodized oil in the body. After ingestion, the oil is absorbed by the lacteals, part being split by digestion, releasing the iodine. Excretion of the iodine by the urinary tract is rapid, reaching a maximum in the first twenty-four hours. Excretion following intratracheal injection is slightly more delayed. From the lungs most of the oil is coughed out, aided by slow ciliary flow. Urinary excretion after instillation in the lungs reaches a maximum on the fourth day and is probably secondary to absorption of swallowed oil. The oil is rapidly discharged from a healthy lung but may remain in a diseased lung for months. Absorption from other parts of the body is very slow. Iodism is most apt to occur when the oil enters the digestive tract.

Some degree of general and local sedation is advisable. Morphine may be used for general sedation and to depress coughing. Local application of cocaine is advisable in patients who are not sensitive to it. Pharyngeal anesthetization by means of a spray and laryngotracheo-bronchial anesthetization by the same route to be used in instilling the oil are advisable.

The oil should be used at room temperature. Warming it may so decrease the viscosity that the alveoli will be flooded.

Bronchography is contraindicated in the presence of hypersensitivity to iodine, acute sepsis, acute febrile tuberculosis, and poor general condition. The chief dangers are sensitivity, spread of infection, blockage of bronchioles, and reduction of alveolar surface for gaseous interchange.

The cricothyroid method consists in instilling the oil through the cricothyroid membrane with a syringe and needle. Pharyngeal anesthesia is not necessary with this method. It is particularly useful in unconscious patients. Its disadvantages lie in the possible complications: glottic edema, peritracheal infection, peritracheal extravasation of oil, emphysema, hemoptysis, and neck pain. Posturing in the prone position is practically impossible with this method.

Of peroral methods, the simplest is "passive deglutition." The pharynx, particularly the fauces, is well anesthetized, but anesthetization of the esophageal orifice is to be scrupulously avoided. When the anes-

thesia is at its height (when the patient cannot elevate his larynx) the oil is swallowed. The chief advantage of this method is its simplicity. There are no contraindications. It is not as uniformly successful, however, as other peroral methods.

Peroral supraglottic instillation is accomplished by dropping the oil with a catheter or cannula over the back of the tongue following local anesthesia. This method is simple and rapid and causes less apprehension in the patient. The chief disadvantage is the difficulty in filling the upper lobe bronchi.

Peroral transglottic cannularization is more straightforward and there is less likelihood of swallowing the oil. Posturing is not too easy with this method. Skill in indirect laryngoscopy is essential.

Peroral endotracheal catheterization has certain advantages, in particular the possibility of directing the catheter into any desired bronchus.

The bronchoscopic method is more formidable and requires special skill. The advantages claimed for it are that undesirable secretions may be removed and selection of a particular bronchus is more feasible. The main disadvantages are the ordeal for the patient and the difficulty of positioning with the bronchoscope in place.

Pernasal instillation and pernasal endotracheal catheterization are practically the same as the two corresponding peroral methods and have the same advantages and disadvantages.

A complete bronchogram implies the visualization of all the bronchi of both lungs. This requires changing the patient's position during the instillation. Six positions are recommended, about 5 c.c. of oil being instilled for each of the first four and, if necessary, for the remaining two: (1) seated, inclined 20 degrees posteriorly and to the right, (2) seated, inclined 20 degrees forward and to the right, (3) seated, inclined 20 degrees posteriorly and to the left, (4) seated, inclined 20 degrees forward and to the left, (5) left Trendelenburg and (6) right Trendelenburg. The instillation is best done under fluoroscopic control, and if the oil is not flowing where it is wanted the position may be modified.

Commonly no aftercare is required, but patients whose throats have been anesthetized should be cautioned not to eat or drink for at least an hour or until the throat feels normal.

The author's choice of method is: (1) for the patient who can stand or sit or is orthopneic, pernasal catheterization unless visualization of the upper lobe bronchi is not of paramount importance, in which event the pernasal or peroral supraglottic technic may be employed; (2) for the patient unable to stand or sit: (*a*) endotracheal catheterization either pernasally or perorally (the latter under indirect laryngoscopic control); (*b*) pernasal or peroral supraglottic instillation if the head can be raised sufficiently to prevent pooling in the mouth or pharynx; or (*c*) possibly the cricothyroid method; (3) for the patient under general anesthesia, use of an endotracheal tube, the pernasal or peroral supraglottic method with the head elevated, or the cricothyroid method.

The general conclusion is reached that in routine bronchography there is no place for the bronchoscopic method and that in all except a questionable minority of cases the cricothyroid technic is unnecessary.

Twenty-five roentgenograms.

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Delayed Pneumonia and Urticaria Following Bronchography. H. E. Bass. New England J. Med. **240:** 505–507, March 31, 1949.

A 59-year-old male had an infiltrative lesion in the upper left chest from which no tubercle bacilli could be obtained. A bronchogram was made, with the use of lipiodol instilled by means of an intratracheal catheter. Fourteen days after this examination, a productive cough and a rise of temperature occurred. At the same time, an urticaria developed over the arms, legs, and trunk. Roentgen examination of the chest showed a pneumonia in the lower left lung area. Numerous densities representing the lipiodol were visible throughout the left lung. Follow-up examination showed slow resolution of the pneumonic process.

The late development of the pneumonia and urticaria following bronchography in this case suggests that both were on an allergic basis and due to lipiodol. The patient had had previous eruptions described as "hives."

There is usually a history of allergy of some sort in cases such as this. Since it is probably the iodine content of the oil that is responsible for the reaction, iodine sensitivity tests are indicated in patients with a familial or personal history of allergy. It is further suggested that over-filling of the bronchial tree should be avoided and that postural drainage should be attempted following examination. The importance of keeping the patient under observation for two weeks after bronchography is emphasized.

Three roentgenograms.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Bronchography in Cases of Foreign Body. Eelco Huizinga. Acta oto-laryng. **37:** 124–130, April 1949.

Most foreign bodies in the bronchi can be located by simple roentgenography, with demonstration of bronchostenosis, obstructive emphysema, and atelectasis. In difficult cases, however, bronchography may be of assistance in determining whether a foreign body is actually present, its exact location, and the presence of any complication. Several illustrative cases are included.

Seven roentgenograms.

Ectopia Bronchi. William H. Falor and A. H. Kyriakides. J. Thoracic Surg. **18:** 252–260, April 1949.

A short review of the literature on the embryology of the lung is presented. The authors conclude that the theory of lung development advanced by Heiss (Ztschr. f. d. ges. Anat. **24:** 244, 1923) is correct. This theory proposes that the lung develops peripherally first and progresses toward the main stem bronchus rather than *vice versa*. One case is presented which is believed to support this theory.

A chest roentgenogram on a 9-year-old boy showed a large lung cyst filling the left chest, with all the bronchi in the lower medial part of the chest and the mediastinum shifted to the right. The chief complaint was dyspnea on exertion. The left lung was removed, and on dissection the upper lobe was found to be greatly distended and to be made up of thin-walled emphysematous blebs. A number of terminal bronchi were observed microscopically. No major bronchus led into this area. All of the usual bronchi found in an entire left lung were present in the atelectatic lower lobe. A few very small peripheral bronchi from this lobe crossed

the interlobar fissure into the upper lobe. These were the only means of entrance of air into the upper lobe.

The authors assume that the mesenchymatous anlage of a normal left lung gave rise to the two lobes of this specimen. The presence in the lower lobe of all the bronchi normally found in an entire lung has been interpreted as an *ectopia bronchi* of the left upper lobe. In the absence of a major bronchial communication to the upper lobe, it is impossible to explain the presence of bronchi in that lobe by the usual theory of lung formation, which states that the lungs develop from the main stem bronchus outward. Therefore the authors believe that the epithelium of the small bronchi in the upper lobe arose from the original bud of the left upper lobe and it remained only for the larger bronchi arising centrally to join these smaller elements to complete a normal bronchial architecture.

Five roentgenograms; 2 drawings; 3 photomicrographs.

HAROLD O. PETERSON, M.D.
University of Minnesota

Lung Hernia. A Case Report and Review of Literature. Jerome J. Hurwich. J. Thoracic Surg. **18:** 261–268, April 1949.

A true lung hernia is defined as a protrusion of the lung and its pleural membranes through an abnormal opening in the thoracic enclosure. Less than 200 cases have been reported, the first case being that of Plater in 1641. The Morel-Lavalleé classification is given:

I. According to location
   A. Diaphragmatic
   B. Thoracic
   C. Cervical
II. According to etiology
   A. Congenital
   B. Acquired
      1. Traumatic
      2. Consecutive
      3. Spontaneous
      4. Pathological

The diaphragmatic type is questioned as a true hernia and most writers consider it as a prolapse. Mediastinal hernia is considered a true hernia and may be anterior or posterior. Cervical hernias occur through the superior aperture of the thorax due to a scar or deficiency in Sibson's fascia. These are usually congenital.

The most common types are the thoracic or intercostal. They occur near the sternum or posteriorly near the vertebrae as a result of a *locus minoris resistentiae* due anatomically to the fact that the external intercostal muscles extend forward only to the costochondral junction while the internal intercostal muscles end posteriorly at the angles of the ribs.

A review of the reported cases shows 18 per cent to be congenital, 50 per cent traumatic, 32 per cent spontaneous. The incidence is three times as great in males as in females. Traumatic hernias may develop any time after injury; those appearing late constitute the "consecutive type" in the classification quoted above.

Spontaneous lung hernias may result from an area of local decreased resistance in the boundaries of the chest cavity and an abnormal increase in the air pressure. They have been reported in association with whooping cough, foreign bodies, weight-lifting, playing wind instruments, and childbirth. Pathologic varieties may be due to abscess of the breast, cancer, etc.

There are three cardinal symptoms: a local bulge, cough, and pain at the site of the bulge. Early traumatic hernias may be obscured by the causative injury. The hernias are rarely incarcerated.

Prognosis is good; complications are rare. Treatment is surgical, for the traumatic and congenital types rarely heal spontaneously.

One case is reported, following extensive multiple rib fractures after an automobile accident. Successful repair was accomplished.

Two roentgenograms.

HAROLD O. PETERSON, M.D.
University of Minnesota

Lipoid Pneumonia in Neuropsychiatric and Debilitated Patients. Arthur A. Humphrey and Edwin G. Olmstead. Dis. of Chest **15:** 471–479, April 1949.

The authors report 4 cases of lipoid pneumonia, proved postmortem, in neuropsychiatric and debilitated patients. The initial diagnoses were post-encephalitic Parkinson's disease in one, cerebral thrombosis in another, and Huntington's chorea in two. Three patients received mineral oil because of constipation, and one was given cod-liver oil twice a day for forty-two days. The patients were more or less helpless, and one had difficulty in swallowing. All had repeated respiratory infections, with roentgen evidence of pulmonary infiltration. Microscopically one case showed fibrous thickening of the alveolar walls, obliteration of many alveoli due to connective-tissue proliferation, and numerous foreign body giant cells. These changes were attributed to the phenophthalein which was given in a mineral oil preparation.

Clinically the diagnosis of lipoid pneumonia is based upon a history of ingestion of oily substances, repeated bouts of pneumonia, the demonstration of oily droplets in the sputum following a lipoid-free diet, and x-ray findings which, while not specific, are characteristic in the sense that they are persistent even though the patient may be asymptomatic.

One roentgenogram; 2 photomicrographs.

HENRY K. TAYLOR, M.D.
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Hemosiderosis of the Lung Due to Mitral Disease: A Report of Six Cases Simulating Pneumoconiosis. Eugene P. Pendergrass, Edwin L. Lame, and Herman W. Ostrum. Am. J. Roentgenol. **61:** 443–455, April 1949.

This report deals with mitral valve disease accompanied by deposition of hemosiderin in the lungs, in such fashion that roentgenograms reveal a fine nodulation, much like pneumoconiosis or miliary tuberculosis. Six cases of this rare occurrence are reported, 4 of which were studied at autopsy. Only 17 autopsied cases have been previously reported and not all of these demonstrated a clear granular roentgen pattern.

Nodular lung lesions seen in the roentgenograms and confirmed histopathologically as siderosis have been described among arc welders, silver finishers (who use iron oxide), and grinders of ferrous metal. These are examples of exogenous siderosis of the lungs. Endogenous pulmonary siderosis is exemplified by this group of mitral heart disease patients and by certain children suffering from severe anemias.

All four autopsied cases showed chronic passive congestion. Two cases revealed hemosiderosis and two

siderofibrosis. All histopathologic slides showed nodular aggregates, from 1 to 3 mm. in diameter, visible to the naked eye and identifiable as areas of hemosiderin deposit.

From this and other reported studies it would appear that focal clumps of hemosiderin and macrophages can cause densities large enough to be seen on roentgenograms of the lungs. This may occur in patients dying of rheumatic heart disease with severe passive congestion as well as those without clinical evidence of congestion of the lungs. These latter are supposed to be supporting an "inactive chronic passive congestion."

The authors point out that the finely divided nodular lung lesions must be differentiated from the common pneumoconioses and from miliary tuberculosis. About 18 other entities to be considered are listed. The telltale evidence consists of the mitral configuration of the heart and the history of rheumatic valvular disease.

In the discussion G. V. LeRoy questions the grouping of hemosiderosis and siderofibrosis with the so-called exogenous sideroses. The latter are pneumoconioses. In the former, iron forms less than 1 per cent of the hemosiderin molecule. The possibility is suggested that part of the changes may be due to the occurrence of passive congestion with calcification and even ossification rather than reaction to the iron *per se*.

Seventeen roentgenograms; 10 photomicrographs.

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Silicosis. J. Marsh Frére. South. M. J. **42:** 271–275, April 1949.

A general discussion of silicosis is presented, based on the author's study of 348 chest films and a review of the literature. The roentgen and pathological aspects of the various stages are described. The author is not in agreement with those who think that the roentgenologist in his interpretation of the roentgenogram should determine the presence or absence of disability. He is of the opinion that this reponsibility should be shared by the physician who makes the physical examination, who studies the heart (electrocardiogram), the lungs (vital capacity and breathing exercises), and the laboratory reports, including blood counts, Kahn test, sedimentation rate, sputum, and urinalysis.

Six roentgenograms.

Lipoid Granulomatosis (Xanthomatosis) with Marked Pulmonary Fibrosis and Cor Pulmonale as Outstanding Manifestations. Samuel J. Schneierson and Louis Schneider. Ann. Int. Med. **30:** 842–851, April 1949.

Xanthomatosis of the skeletal type has become clearly established as a disease found principally in children. Pulmonary infiltration has been reported by a number of writers; most often it is an incidental finding discovered in the course of chest roentgenography. Pulmonary infiltration extensive enough to result in congestive right heart failure (as in the authors' case) is distinctly rare.

In a white male, age 35, a radiographic examination of the chest revealed an extensive interstitial fibrosis throughout both lungs, from apex to base. The heart was moderately enlarged, with definite prominence of the pulmonic conus and enlargement of the left and right ventricles. A roentgenogram of the skull disclosed a large, irregular, geographic, quadrilateral area of bone destruction in the right parietal region, approximately 8 × 4 cm. in extent. The general appearance of this lesion indicated the possibility of lipoid granulomatosis. Further radiographic examination disclosed several small cystic areas of bone destruction in the shaft of the right femur, with thickening of the cortex along the upper third and similar destructive lesions in the descending ramus of the left pubic bone. Other skeletal studies were negative.

On Aug. 29, 1946, a biopsy of the lesion of the right parietal bone was performed, and a diagnosis of lipoid granuloma of the skull (of the type seen in Schüller-Christian disease) was made.

Beginning on Oct. 3, 1946, the patient was given deep roentgen-ray treatment to the anterior and posterior chest fields, at five-day intervals, for a total of 800 r (200 kv., 0.5 mm. Cu and 2 mm. Al filter). On Jan. 21, 1947, a chest film disclosed increased cardiac enlargement. The pulmonary infiltration, while still pronounced, appeared to have diminished, probably as a result of roentgen therapy.

Accounts of treatment of pulmonary lesions by x-rays are rare. Early treatment when the pulmonary infiltration is predominantly granulomatous may be expected to be of greater effectiveness than that administered when fibrous tissue predominates. Such a change is part of the evolution of this disease and likely to render irradiation fruitless.

Four roentgenograms; 2 photomicrographs.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Observations on the Causes of Dyspnea in Chronic Pulmonary Granulomatosis in Beryllium Workers. Robert A. Bruce, Frank W. Lovejoy, Jr., George B. Brothers, and Tulio Velasquez. Am. Rev. Tuberc. **59:** 364–390, April 1949.

Exertional dyspnea has been the outstanding symptom in the chronic pulmonary granulomatosis due to inhalation of beryllium compounds in a finely divided state. Other symptoms are weight loss, irritative cough, intermittent chills and fever, and anorexia. Physical findings include cyanosis, clubbing of fingers, orthopnea, and cough.

Observations on the cardiorespiratory function of six patients with chronic pulmonary disease due to beryllium are reported. The diagnosis was made by exclusion in four cases and beryllium was found in renal stones in a fifth and in the urine of the remaining patient. Extensive studies were done, including tests of maximum breathing capacity, lung volume, vital capacity, and blood gases (including data obtained by cardiac catheterization). In addition, electrocardiograms, ballistocardiograms, pneumocardiograms, venous pressures, circulation times, and exercise studies were obtained during periods of hospitalization.

The impaired diffusion of oxygen from the alveolar spaces to the pulmonary capillaries is held to be the keystone of the abnormal physiology in this disease. Five of the patients studied were anemic, and the sole compensatory mechanism for the hypoxemia resulting from the granulomatosis was found to be hyperventilation. In comparison to the normal ventilation volumes at rest, the patients showed variations of from 40 to 240 per cent hyperventilation. The additional factor of contracted breathing capacity and decreased total lung volume (particularly the complemental air) add to the anoxemia. This type of pulmonary insufficiency more nearly resembles that seen in patients with pulmonary

fibrosis than in those in whom emphysema is the primary defect. Pathological studies in fatal cases have shown a combination of diffuse emphysematous alteration and granulomatous infiltrations.

Functional studies of the type undertaken do not offer data which differentiate this disease from others of comparable severity, but they serve as a means to study the progress of the pulmonary disability, and the complications or compensatory mechanisms as they appear. The earliest response was found to be hyperventilation, with polycythemia appearing in only one patient. The failure of an increase in hemopoietic activity in these and other cases of beryllium granulomatosis is not clearly understood. Cor pulmonale develops after the onset of pulmonary hypertension and was present in two of the patients included in this study. Secondary effects were found to be those of malnutrition and liver and renal disease; the cause for these effects was not determined. Oxygen therapy was necessary to prevent overwhelming anoxemia but was otherwise not specific, and cytochrome C therapy produced no particular benefit.

Six roentgenograms; 7 tables; 7 charts.

JOHN H. JUHL, M.D.
University of Wisconsin

Early Diagnosis as the Means of Tuberculosis Control. Eugene D. Rames. Dis. of Chest. **15:** 404–411, April 1949.

At the University of Minnesota, with an enrollment of approximately 27,000, each student is subjected to a photofluorographic examination and tuberculin test in addition to the physical examination required on admission. The program has two main objectives: (1) the detection of disease in any student who might be infected; (2) supervision and rehabilitation of the tuberculous among the student body. This detection plan permits the recognition of the disease in its earliest stages and results in isolation of the contagious and the institution of therapy at a time when the greatest recovery rate can be expected.

Nine case histories are included to show the variety of situations encountered. These illustrate the important role of the tuberculin test in any tuberculosis control program. In the six months prior to the preparation of this paper, about 20 new cases of tuberculosis were detected.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Routine Photofluorography of the Chest. John A. Mart, Kenneth V. Powers, and Earl E. Barth. Illinois M. J. **95:** 236–239, April 1949.

The authors report a survey of 1,055 adults examined routinely with 4 × 5-inch stereoscopic chest films on admission to the Montgomery Ward Clinics of the Northwestern University Medical School. In 5.5 per cent significant chest lesions were revealed. In a second series, comprising a similar number of patients, roentgen examinations were done only when specifically indicated (364 cases). Significant pulmonary lesions were found in only 2.39 per cent of this second series.

The authors believe that photofluorography of the chest is an advisable routine procedure in health examinations, and a recommended procedure for all patients who seek medical care. The tuberculin test was found to be of little value as a "screening test" in the survey.

Three tables.

EDSEL S. REED, M.D.
University of Louisville

Coexisting Disseminated Coccidioidomycosis and Tuberculosis. Report of a Case. George M. Firestone and Ellis S. Benson. Am. Rev. Tuberc. **59:** 415–428, April 1949.

The case presented is the sixth in which coexistence of tuberculosis and coccidioidomycosis has been reported. The authors believe it to be the first in which disseminated coccidioidomycosis and tuberculosis have been found.

The patient, a 34-year-old white enlisted man, had been in San Diego, Calif., for six months and at an army camp at Compton, Calif., for less than one month prior to the onset of symptoms in August 1942. The initial symptoms were pain and stiffness in the neck followed by enlargement of the anterior cervical nodes and cough, with associated general malaise and anorexia. A chest roentgenogram showed infiltrative disease in the right apex, and a biopsy of a skin nodule showed a "mycotic granuloma due to *Coccidioides immitis*." From that time until his death in February 1948, the patient was in and out of a number of hospitals with recurring skin nodules, all due to *Coccidioides*, and relative quiescence of the pulmonary lesions until some time prior to his final admission in December 1947, when widespread disease was noted throughout both lung fields.

Autopsy revealed histologic evidence of disseminated coccidioidal infection in the lungs, liver, spleen, adrenals, kidneys, prostate, thyroid, meninges, brain, skin, hilar and mediastinal nodes, and tonsils. Tuberculosis was found in the lungs, tonsils, ileum, and seminal vesicles. There was hematogenous dissemination of the tuberculosis only to the seminal vesicles, so far as could be determined. The existence of the two diseases was evidently coincidental, with the individual coccidioidal granulomata devoid of tubercle bacilli and the tubercles containing only a few *Coccidioides* spherules at the periphery.

During the course of the disease streptomycin apparently partially controlled the tuberculosis but did not affect the coccidioidal disease. Potassium iodide and vitamin D_2 in massive doses seemed to decrease some of the manifestations of the latter.

Three roentgenograms, 1 photograph, 2 photomicrographs.

J. H. JUHL, M.D.
University of Wisconsin

Diagnosis and Treatment of Lung Tumor. Ralph Adams. Am. Rev. Tuberc. **59:** 353–363, April 1949.

Carcinoma of the lung accounts for 6 to 8 per cent of all cancer and is therefore likely to be encountered by every physician. Early detection is occasionally accomplished in group surveys, but there is need for (1) education of the public to seek medical aid for cough of two weeks duration; (2) education of the medical profession in methods of examination; (3) elimination of symptomatic treatment of cough without thorough investigation of its cause.

Symptoms of cough, vague thoracic discomfort or pain, sputum, hemoptysis and wheezing may occur relatively early, while dyspnea, severe pain, hoarseness, and debility are late manifestations. Physical findings are those related to bronchial obstruction. Chest radiography, including lateral and oblique views as indicated, as well as laminagraphy and fluoroscopy, excels all other methods of detection in the opinion of the author. Sputum should be examined for cancer cells in all suspected cases. Bronchoscopy in compe-

tent hands is also an important procedure. The author does not believe in using bronchography in the study of lung tumors. Exploratory thoracotomy is indicated in the occasional case in which other methods of study have been indecisive. The operative mortality is now approaching zero and more early lesions of doubtful etiology are being discovered.

Pulmonary resection, the only method of cure, carries a 5 per cent mortality in the hands of the author on the basis of a 30 per cent resectability rate. The one-year survival rate for cases with resection is 64 per cent. As previously reported by the author (J. A. M. A. **130:** 547, 1946. Abst. in Radiology **48:** 93, 1947), 23 per cent of patients treated by resection were alive and well five years later. Resection for palliation is indicated in a few selected cases. Palliative x-ray therapy is often useful in the presence of severe pain or pleural effusion and in highly malignant tumors.

In contrast to the results in carcinoma, over 90 per cent of patients with bronchial adenoma survive without evidence of disease for a five-year period following resection. The author feels that because of the difference in the clinical course and prognosis, this tumor should be segregated from carcinoma in survival-rate statistics, despite the controversy regarding the similarity or dissimilarity of the histology.

J. H. JUHL, M.D.
University of Wisconsin

Bronchial Carcinoma: An Unusual Radiological Finding. F. Greenwood and W. L. Phillips. South African M. J. **23:** 245–246, April 2, 1949.

This is an isolated case report of a pedunculated bronchial carcinoma which caused a ball-valve obstruction during inspiration. During quiet respiration no abnormality was evident on fluoroscopy but with full inspiration a marked shifting of the mediastinum to the right was observed, with a difference in aeration of the two lungs. Films in inspiration and expiration as well as a tomograph visualizing the tumor are reproduced.

Three roentgenograms; 1 photomicrograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Metastatic Cancer of the Lung. Robert C. Pendergrass. South. M. J. **42:** 303–310, April 1949.

The radiological aspects of secondary cancer of the lung fall into three general groups: (1) detection of metastases on routine chest examinations; (2) detection of metastases in known cancer cases; (3) classification of metastatic lesions as regards treatment.

The usual modes of metastasis to the lungs are: (1) through the chest wall directly to the pleura; (2) *via* the lymphatics to the mediastinal nodes and hence into the lung parenchyma; (3) by vascular channels.

Various guises are assumed by the metastatic lesions, as (1) pleural thickening or effusion, (2) linear infiltration, (3) solitary or multiple annular shadows, (4) miliary seedings, (5) apparently cystic lesions, (6) bronchial stenosis with atelectasis or emphysema, (7) mediastinal or peribronchial adenopathy. Because of the varied manifestations, the differential diagnosis is beset with pitfalls. To the roentgen findings there must be added a detailed history, complete physical examination, clinical laboratory tests, and a reasonable amount of diagnostic logic.

There are four approaches in treatment: (1) radiation therapy; (2) endocrine therapy; (3) radioactive isotopes and nitrogen mustard; (4) surgery for solitary metastasis. Of these, lobectomy is considered the most promising in cases of a solitary pulmonary metastasis, several cases of complete recovery having been reported. The other three methods are mainly palliative.

Roentgenologic examinations of the chest should constitute a part of the follow-up examination on all cancer patients except those with small skin lesions.

Sixteen roentgenograms.

HARVEY J. THOMPSON, JR., M.D.
Jefferson Medical College

Mediastinal Cysts of Gastric Origin. Report of a Case. B. J. Bickford. Brit. J. Surg. **36:** 410–413, April 1949.

Cysts in the posterior mediastinum are almost invariably associated with anomalous development of the primitive foregut. They usually contain two or even three layers of smooth muscle and may be lined by epithelium similar to that found in the trachea, esophagus, stomach, or small intestine. Other congenital abnormalities frequently accompany these cysts.

Enterogenous cysts are usually found in children and their presence has generally been incompatible with long survival. When the cyst is lined with gastric mucosa, it may be associated with peptic ulceration into the pleura or lung, or erosion of blood vessels or vertebral column.

One case, in a 3-year-old male child, is presented, with a history of dyspnea, cough, and occasional cyanosis, which were worse when the patient was sitting. Roentgenograms of the chest showed a rounded shadow in the right posterior mediastinum and an associated congenital anomaly in the upper thoracic vertebrae and ribs. A cyst filled with a brownish fluid containing crystals, presumably cholesterol, was removed. The lining epithelium was similar to that of the gastric cardia, and one area of typical chronic peptic ulceration was noted.

The author suggests that early thoracotomy should be advised in cases presenting a rounded posterior mediastinal shadow. The possibility of a gastric cyst should be considered in dealing with obscure thoracic and clinical pictures in childhood.

Three roentgenograms and four photomicrographs.

P. B. LOCKHART, M.D.
Indiana University

Pulmonary Embolism. Analysis of 74 Autopsy Cases Since 1941. Klaus Dehlinger and Paul Riemenschneider. New England J. Med. **240:** 497–501, March 31, 1949.

This study of 74 cases of pulmonary embolism seen at autopsy was undertaken in the hope of explaining the decrease (relatively insignificant) in the number of such cases coming to autopsy (at the New England Deaconess and New England Baptist Hospitals) since the use of definitive and prophylactic treatment of venous thrombosis, including venous interruption and the administration of heparin and dicumarol. Since only 5 of the 74 patients received specific therapy for the prevention of embolism, it seems that the primary problem is the difficulty in the diagnosis of venous thrombosis and non-fatal pulmonary embolism.

Roentgenograms are not so helpful as one might think. In only 28 of the 74 fatal cases were there sufficient chest symptoms during the last week before the

final agonal episode to warrant x-ray examination of the chest. In 18 of these 28 cases pulmonary embolism was not recognized radiographically because of additional coexistent pulmonary and pleural abnormalities as shown by autopsy. This leaves only 10 cases with x-ray films available in which pulmonary embolism with or without pulmonary infarction was the sole pathologic finding in the lungs at autopsy. Chest roentgenograms of 5 of these showed no abnormal densities in the lung fields, so that in all probability the emboli lodged in the pulmonary arteries after the film was taken. In the remaining 5 cases, the greatest misinterpretation of shadows cast by lung infarcts as the only pathologic process found at autopsy was the diagnosis of pneumonitis or bronchopneumonia (4 cases).

Two drawings: 4 tables.

Arteriovenous Aneurysm of the Lung. Charles Baker and J. R. Trounce. Brit. Heart J. **11:** 109–118, April 1949.

Few cases of arteriovenous aneurysm of the lesser circulation are found in the literature, for the condition has only recently been recognized as an entity. We can expect to encounter it more frequently with the increased interest in congenital heart disease.

Cyanosis, polycythemia, and clubbing are the striking features. The heart is found to be normal on both clinical and roentgen examination, but localized densities are demonstrable in the lungs, over which murmurs can be heard. The cyanosis results from shunting of a large proportion of the blood volume (which naturally increases as a compensatory mechanism) through the aneurysm, depriving it of oxygenation.

Two cases are reported in detail. Operation was done in both, one patient dying thirty hours postoperatively.

This article should be read in the original, since the condition described is easily recognizable, once thought of, and there is a reasonable chance for cure by surgery.

Four roentgenograms; 3 photographs; 2 electrocardiograms; 1 table. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Thromboendarteritis with Multiple Mycotic Aneurysms of Branches of the Pulmonary Artery. Conrad L. Pirani, Fred E. Ewart, Jr., and Audrey L. Wilson. Am. J. Dis. Child. **77:** 460–473, April 1949.

The authors present a case of thromboendarteritis of the pulmonary arteries with multiple mycotic aneurysms within the lungs. The septic emboli responsible for the production of these aneurysms arose from a thrombophlebitis of the veins of the lower extremities and the inferior vena cava. Mycotic aneurysms of the trunk and primary branches of the pulmonary artery are rare but occur more frequently on the basis of an endocarditis than thrombophlebitis as in the case described.

The patient, an adolescent Greek boy, had a persistent productive cough, chills, fever, general malaise, and later hemoptysis. These symptoms were progressive until death. Slight edema of the extremities occurred late in the course of the disease. Radiographs showed rounded hilar shadows, with fuzzy, blurred edges, and changes in both lung fields suggesting lymphogenous spread of a metastatic neoplasm. A lymphoma was also considered. As the patient was thought to have a metastasizing tumor obstructing the inferior vena cava, x-ray therapy was given to the abdomen. Antibiotics were not effective. Subsequent chest radiographs showed progression in size of the hilar shadows and the development of smaller rounded pulmonary densities. Death occurred eleven months following the onset of symptoms.

Autopsy revealed thromboendarteritis of the pulmonary arteries with multiple large and small mycotic aneurysms. The inferior vena cava, iliac veins, and veins of the lower extremities showed old thrombophlebitis with partial recanalization. Death had resulted from rupture of a pulmonary aneurysm.

The authors point out the lack of pathognomonic or reasonably characteristic roentgenographic findings in this entity. They were unable to find a reported case diagnosed during life. A previously recorded aid in differentiation (vascular connection of the areas of density with the hilus) could not be demonstrated in their case. In retrospect they feel that the blurred borders of the rounded pulmonary and hilar shadows should have suggested an infectious rather than a neoplastic process. The possibility of diagnosis by contrast media is suggested. The authors believe this condition should be considered in cases of chronic thrombophlebitis or bacterial endocarditis with unusual pulmonary shadows and hemoptysis.

Nine illustrations, including 3 roentgenograms.
R. R. SURRATT, M.D.
Baton Rouge, Louisiana

Cardiac Aneurysm. Max Caplan and Paul M. Sherwood. New England J. Med. **240:** 629–637, April 21, 1949.

With increased diagnostic facilities, cardiac aneurysm has been more frequently recognized in recent years. Two detailed case reports are presented here.

The first patient, a 56-year-old male, was admitted for convalescent care, with a history of frequent episodes of chest pain and one very sudden severe attack of substernal and precordial pain which radiated down both arms. Two weeks and four weeks later, similar but milder attacks had occurred with subsequent improvement. On admission, the maximum cardiac impulse was found to be heaving, appearing in the fourth interspace, just medial to and below the left nipple. The heart sounds were distant and of poor quality. No murmurs were heard. An x-ray examination of the chest showed cardiac enlargement with a prominence and dilatation of the left border. Fluoroscopically, this prominence was seen to pulsate with each contraction of the left ventricle. Repeated films over a two-year period showed no change. The patient is able to do light work.

The second patient was a 70-year-old male who gave a history of sudden severe pain in the anterior left chest with sweating and shortness of breath nine months earlier. An electrocardiogram at that time indicated myocardial damage, coronary occlusion, and sinus tachycardia. An x-ray examination a little later showed cardiac enlargement, and the question of cardiac aneurysm was raised. On admission, on account of increasing dyspnea, the maximum cardiac impulse was found to be displaced above the left nipple inside the midclavicular line. The sounds were distant but regular. Blood pressure was 150/90. X-ray examination showed considerable cardiac enlargement, with a bulging of the left ventricular contour. Under treatment, the patient became asymptomatic and ambulatory.

Cardiac aneurysm may be rheumatic, syphilitic, congenital, traumatic, or mycotic in origin, but at least 85 per cent of the cases are due to coronary artery disease and in about 1 out of 10 cases of that condition an aneurysm develops. The aneurysmal dilatation is due to the thinning of scar tissue with relaxation and protrusion of that part of the heart wall. The aneurysm itself is asymptomatic, but the anginal syndrome or symptoms of left ventricular failure may be present as a result of the underlying cardiac disease. On palpation, the cardiac impulse may be found to be above the normal site and this is considered by some to be the characteristic finding. The heart sounds are usually diminished, with a dull first sound and a poor tone. A systolic murmur is sometimes present in the area of abnormal pulsation and there may be a gallop rhythm. Blood pressure is usually normal or below normal. The electrocardiogram is said to be of no specific diagnostic value.

On roentgen examination, a prominence of the cardiac border is usually distinguished, which is more easily defined at fluoroscopy. At times, the aneurysmal dilatation can be seen to pulsate. Calcification within the thrombus or the wall of the sac may be found. Angiocardiography may be of diagnostic aid. In differential diagnosis, cardiac and pericardial tumors, mediastinal tumors, and abscesses must be considered.

The course is primarily dependent upon the coronary artery disease rather than on the aneurysm.

Six roentgenograms; 2 electrocardiograms.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Myocardial Infarction and Cardiac Aneurysm: Their Roentgen Diagnosis. Eric Samuel. South African M. J. **23:** 247–254, April 2, 1949.

The essential basis of the roentgen diagnosis of myocardial infarction is accurate fluoroscopy, with observation of changes in the cardiac pulsations and in the cardiac contour. Changes in pulsation can also be recorded kymographically, but fluoroscopy is probably more accurate, since the kymographic curves are the result of two independent types of motion.

Pulsation of the involved area is always diminished, may be completely absent, and is said by some to be paradoxical at times. A localized flattening over the left border of the heart is best seen on the routine chest film.

Cardiac aneurysms show an abnormal bulging of the cardiac contour, absent or abnormal pulsation, and sometimes calcification of the aneurysmal wall. They must be differentiated from cysts, aortic aneurysms, periapical fat pads, and encapsulated effusions.

Seventeen roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Aneurysm of the Left Ventricle Secondary to Myocardial Infarction. Report of a Case in a Thirty-Five-Year-Old Man. H. L. Newbold, G. B. Wyatt, and T. F. Frist. South. M. J. **42:** 323–325, April 1949.

A case of ventricular aneurysm is reported which was unusual because of its occurrence in a young man, subsequent to early ambulation following myocardial infarction. The patient, aged 35, had been put to bed immediately after the initial illness by his family physician. An electrocardiogram taken shortly after the acute episode having been interpreted as normal, he returned to work after one week in spite of anginal pain and some dyspnea on exertion. Subsequent studies were undertaken six weeks after the attack, and were all more or less indeterminate except the roentgenogram of the chest, which revealed a picture typical of aneurysm of the left ventricle.

The authors consider that the physical findings in the usual case of this kind are not reliable as diagnostic criteria, while the electrocardiogram, as in this instance, may show only the patterns of myocardial infarction.

One roentgenogram; 1 electrocardiogram.

HARVEY J. THOMPSON, JR., M.D.
Jefferson Medical College

Diagnosis of Coarctation of the Aorta. William L. Proudfit and A. Carlton Ernstene. J. A. M. A. **139:** 985–988, April 9, 1949.

Twenty-four cases of coarctation of the aorta were analyzed from the point of view of diagnostic criteria. Palpation of the pulse in the radial and femoral arteries is enough to give the examiner a very strong suspicion that this condition is present. The most constant diagnostic sign consists in diminution or absence of pulsations in the femoral arteries, while the radial pulses may be unequal in the two arms.

The blood pressure in the upper extremities is almost always elevated [both arms should be tested since occasionally the left subclavian comes off at or near the coarctation]. Systolic pressure in the lower extremities is always lower than in the upper and may be unobtainable. Collateral vessels may be visible or palpable, especially around the shoulders and intercostal spaces.

On x-ray examination there is almost always some scalloping of the costal grooves (except in children). The heart is often enlarged and the aortic knob is usually small or not seen. Since coarctation of the aorta is a surgically correctable disease, anyone doing survey work should remember to look specifically at the costal grooves and the aortic knob.

Three roentgenograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Calcified Aortic Valve. Clinical and Radiological Features. C. E. Davies and R. E. Steiner. Brit. Heart J. **11:** 126–136, April 1949.

Fourteen cases of calcification of stenotic aortic valves are analyzed. In every one the calcification was demonstrated by tomography, a method not previously used, at least in cases recorded in the literature. Tomography was much more accurate than other methods, since only 4 cases showed calcification on an over-penetrated film and in only 6 could it be positively seen at fluoroscopy, with 3 others doubtful.

Tomography was done with the patient supine in the left posterior oblique position (right side raised). The tube was centered 10 cm. below the suprasternal notch in the midline. An arbitrary plane was selected 13 or 14 cm. from the table top and several sections at 1-cm. intervals were taken above and below this level.

Clinical features of aortic stenosis are also discussed rather fully.

Seven roentgenograms, including 5 tomograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Morbus Cœruleus: A Study of 50 Cases After the Blalock-Taussig Operation. Charles Baker, R. C. Brock, Maurice Campbell, and S. Suzman. Brit. Heart J. 11: 170–200, April 1949.

This article reports a comprehensive follow-up on the first 50 cases of congenital heart disease in which a systemic-pulmonary anastomosis was performed at Guy's Hospital, London. The series included 47 cases of the tetralogy of Fallot or some closely related condition and 3 of tricuspid atresia with a non-functioning right ventricle. The cases had been followed for periods of six to fifteen months.

The authors prefer to delay operation to five years of age because of the increased operative risk in younger children and the greater possibility of subsequent return of cyanosis, due perhaps to failure of the anastomosis to grow as the child develops. The dangers of operation after the age of twenty are believed to be definitely greater than at an earlier age, because of shock and the prolonged strain to which the heart has been subjected over the years.

All of the patients in this series were severely disabled, with cyanosis from birth or early infancy, polycythemia, and clubbing of the fingers. In the successfully operated cases, these features showed great improvement or disappeared entirely.

In selecting cases for surgery, the most decisive point is absence of density in the lung fields and lack of pulsation in the hilar vessels. Another important point is the size of the heart. Any enlargement except the most trivial indicates either some complicating defect or lack of cardiac reserve to stand the left-to-right shunt created by surgery. The third point, of almost equal importance, is that there should be no undue prominence of the pulmonary artery, and better still that there should be a striking hollow in the pulmonary region, though some patients may have a rather straight left border. It is important to visualize both right and left pulmonary arteries at fluoroscopy, since one may be absent and death will follow clamping of the pulmonary artery if it is carrying all of the blood to the lungs.

The aortic arch was right-sided in one-fourth of the cases in this series, but the authors have modified Blalock's idea of operating on the side opposite to the arch. Blalock's operation using the subclavian artery is used wherever possible, but the carotids and innominate have been given up because of the high incidence of cerebral damage (50 per cent). If the subclavian cannot be used, then Pott's anastomosis of the aorta and pulmonary artery is done. In that event the approach is made on the same side as the aortic arch. A further variation from Blalock's technic lies in the use of a posterolateral incision, with removal of the fourth rib, instead of an anterior approach. The latter is used, however, if a pulmonary valvulotomy is contemplated.

It is easy to understand that detailed knowledge of the structure and distribution of the great vessels is of the greatest importance in each case before the incision is made. Angiocardiograms supply most of the data, and a number of these are reproduced. In the reproductions, the vessels can be seen but not the heart chambers. Cardiac catheterization was employed in 9 cases, and an appendix on this phase of the study, by G. A. Zaks, is included.

The most important complications of surgery are cerebral thrombosis, congestive failure, and pleural effusion. Fortunately, most of the patients stand the procedure well. The average time in bed in the present series was only seven days. Seven patients died; in 3 anastomosis could not be done; in 3 it was thought to be unsuccessful; in 4 the result was considered "fair." In the remaining 33 it was "almost perfect." Follow-up films of 35 of the patients were obtained and nearly all showed a slight to moderate increase in the size of the heart. One patient with considerable increase died eight months after surgery with a severe bronchitis and congestive failure. The others maintained or increased their early improvement.

Twenty-two roentgenograms; 4 photographs; 5 electrocardiograms; 4 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Complete Transposition of the Aorta and a Levoposition of the Pulmonary Artery. Clinical, Physiological, and Pathological Findings. Helen B. Taussig and Richard J. Bing. Am. Heart J. **37:** 551–559, April 1, 1949.

The authors give the history of a poorly developed white girl of five and a half years, who was dyspneic at rest, and who had been cyanotic since birth. A murmur was audible over the precordium, but no thrill was felt. There was clubbing of the fingers and toes. The red blood cell count, hemoglobin, and hematocrit reading were increased. Arterial blood analysis showed an oxygen content of 17.4 volumes per cent; oxygen capacity of 30.8 volumes per cent; oxygen saturation 57 per cent, and CO_2 content of 25.8 volumes per cent.

X-ray examination showed an enlarged heart, fullness in the middle cardiac segment, and increased hilar markings. Faint expansile pulsations of the hilar shadows were observed. The left auricle was not enlarged. A left aortic arch was demonstrated. The electrocardiogram was indicative of right ventricular hypertrophy.

The clinical findings were characteristic of an Eisenmenger complex except that the cyanosis dated from birth, and the exercise test showed a decrease in oxygen consumed per liter of ventilation.

The results of cardiac catheterization led to the conclusion that the pulmonary artery received oxygenated blood directly from the left ventricle, and that the aorta received a large quantity of unoxygenated blood.

An angiocardiographic examination was made, with 70 per cent diodrast (19 c.c.). The injection was repeated thirty minutes later, but because of a technical fault no exposures were obtained. Fifteen minutes later a third injection was given and a series of 8 films was obtained. There was no immediate reaction, but three minutes later the heart stopped.

The angiocardiograms showed that the dye entered the right auricle and then the right ventricle. Immediately thereafter the aorta was visualized. Very little dye was seen in the pulmonary artery or the lungs. In the second series of films, taken in the lateral position, the aorta appeared to arise from the anterior portion of the right ventricle.

Postmortem examination revealed a transposed aorta, a large pulmonary artery arising primarily from the right ventricle and partially overriding the ventricular septum, a high ventricular septal defect, and right ventricular hypertrophy.

Five illustrations, including one roentgenogram.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Mitral Stenosis in Later Life. Harold Cookson. Brit. Heart J. **11:** 155–164, April 1949.

A series of 38 patients, aged fifty-one to seventy-seven, with mitral stenosis of rheumatic origin is analyzed. Most of the number had been leading fairly normal lives until auricular fibrillation occurred. Fibrillation sooner or later produced congestive failure if untreated.

Roentgen studies showed only one heart in the series presenting a silhouette within normal limits; some hearts were very large. One peculiarity noted in two patients was displacement of the esophagus to the left instead of to the right by the enlarged left auricle. In one case chest films were made just before and after the onset of fibrillation, showing a noticeable difference in the size and shape of the cardiac silhouette. The aortic knob tended to be normal or prominent in contrast to the small knob usually seen in younger patients with mitral stenosis. Hypertension was a fairly common complication, supposedly accounting at least in part for the longevity.

Ten roentgenograms; 3 photographs; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

HERNIA

Hiatus Hernia. G. G. Richards and K. A. Crockett. Arch. Surg. **58:** 411–418, April 1949.

Twenty-four cases of hiatus hernia were seen at the Salt Lake Clinic (Salt Lake City) in eighteen months, a greater number than had been discovered in the preceding thirty years. The patients were between thirty-three and sixty-eight years of age, and 17 were males. Sixteen were overweight. The principal symptom was epigastric or substernal pain, seen in 23 patients; in 7 there was radiation of pain to the left shoulder or arm. Only 1 had dysphagia, and 2 hemorrhage with anemia. Symptoms had been noticed for from six months to twenty years.

A correct diagnosis of hiatus hernia can be made only by roentgenography. While some roentgenologists prefer the supine position with rotation of the patient from side to side, the authors have found examination in the Trendelenburg position more satisfactory. The need of a high index of suspicion is emphasized.

Treatment was generally directed at weight reduction and dietary management, with phrenic crush employed in only 1 instance.

Eight roentgenograms. LEWIS G. JACOBS, M.D.
Oakland, Calif.

Incidence of Hiatus Hernia and Associated Lesions Diagnosed by Roentgen Ray. Irving B. Brick. Arch. Surg. **58:** 419–427, April 1949.

Of 3,448 patients in whom barium studies of the upper gastro-intestinal tract were done in the Boston City Hospital in a two-year period, 705 had duodenal ulcer, 308 had hiatus hernia, 120 gastric ulcer, 101 gastric carcinoma. All patients were examined recumbent as well as erect.

Sex distribution of the hiatus hernias was nearly equal; three-fourths of the patients were in the 50- to 80-year age group. The loss of elasticity of the hiatal tissues with advancing years is thought to contribute to this age distribution. Only extensive herniations occurring in infancy and those of the short-esophagus type are believed to be of congenital origin. In the present series, the hernia was described as small in 223 cases, moderate in 68, and large in 17; 39 were of the short-esophagus type. Seventy-nine patients had various associated lesions, but there was no instance of esophageal ulcer. Symptomatology was varied; there is no pathognomonic pattern. A careful evaluation of the clinical course is necessary to determine the role of the hernia in producing any observed symptom.

Four tables. LEWIS G. JACOBS, M.D.
Oakland, Calif.

Differential Diagnosis of Hiatus Hernia and Coronary Artery Disease. Arthur M. Master, Simon Dack, Jacob Stone, and Arthur Grishman. Arch. Surg. **58:** 428–447, April 1949.

The symptoms produced by hiatus hernia and coronary artery disease may be very similar, and when these conditions co-exist careful evaluation is necessary. Fifty-seven consecutive patients chosen because of roentgenologic evidence of hiatus hernia form the basis of this study; the majority were between forty and seventy years of age. A complete cardiac work-up, including electrocardiograms, and in indicated cases the anoxemia test, led to division into four groups. In one, of 15 patients, only gastro-intestinal symptoms were present, without evidence of heart disease. In a second, of 29 patients, symptoms referable to both systems were found. In 3 patients cardiac symptoms predominated, the hernia being asymptomatic. In 10 patients, anemia resulting from gastric bleeding was the chief cause of symptoms.

The importance of a careful study of these patients from the cardiac standpoint is the more essential, because so large a proportion of this group selected because of the stomach abnormality were found to have significant coronary disease.

The findings in the 57 cases are tabulated and representative case histories are included.

Four roentgenograms; 4 electrocardiograms; 1 table. LEWIS G. JACOBS, M.D.
Oakland, Calif.

Simultaneous Association of Situs Inversus, Coronary Heart Disease and Hiatus Hernia: Report of a Case and Review of Literature. Henry N. Rosenberg and I. N. Rosenberg. Ann. Int. Med. **30:** 851–859, April 1949.

A man of fifty-four, with a five-year history of recurrent chest pain, presented roentgen evidence of congenital dextrocardia and situs inversus and clinical and electrocardiographic findings of coronary heart disease with angina pectoris. He had, also, a symptomatic hiatus hernia demonstrated by the roentgen findings, the clinical history, and response to antispasmodics and diet. The authors believe this is the first such case to be reported. They emphasize the need for careful differentiation of coronary heart disease from hiatus hernia as a cause of chest pain. Much has been written emphasizing the error of making a diagnosis of coronary heart disease in cases where the symptomatology is actually due to hiatus hernia, but the possibility of overlooking a true angina pectoris in the presence of an asymptomatic hiatus hernia has not been equally stressed. From careful clinical appraisal of the symptomatology, electrocardiograms, roentgenograms, the response to treatment with parasympatholytic or antispasmodic drugs, bland diet and coronary vasodilators, a precise

diagnosis may be made, in most cases, with evaluation of the contribution of each lesion to the symptoms.

One roentgenogram; 1 electrocardiogram; 1 table.

A Simple Experimental Method of Evaluation for the Bassini and Allied Types of Herniorrhaphy. F. S. A. Doran and W. H. Lonsdale. Brit. J. Surg. **36:** 339–345, April 1949.

The authors point out that there is a widespread divergence in the published recurrence rates for surgical repair of inguinal hernia. There is no direct evidence to show that in successful clinical results the parts have remained soundly united and in apposition. A simple experimental method of inserting silver wire markers through the lower borders of the conjoined tendon and through the sharp inner edge of the inguinal ligament and following their position radiographically is described. The 13 cases were successful clinically but the majority had definite separation of the conjoined tendon from the inguinal ligament in a few months.

The widely divergent and conflicting opinions which are held about the relative values of different operative technics are due largely to the fallacious manner of the compilation and analysis of the clinical material upon which those opinions are based. An accurate statistical evaluation of the results would have to be based on a properly planned investigation. A brief explanation of the statistical method is given so that the difficulties of efficient statistical investigation can be comprehended. The full value of any type of operation can be judged only by combining experimental and statistical methods.

Seven roentgenograms; 2 charts; 2 tables.

DAVID C. GASTINEAU, M.D.
Indiana University

Coexistence of Intra-Abdominal Lesions in Patients with Epigastric Hernia. John M. Hoffman and Gregg D. Wood. Surgery **25:** 566–575, April 1949.

In 76 patients with epigastric hernia (protrusion of abdominal viscera through an opening in the linea alba anywhere between the umbilicus and xiphoid), coexisting lesions were noted in 24. Examples were duodenal ulcer, cholecystitis, other hernias, etc.

The hernia itself is usually symptomless and, when small, may not be recognized unless the examination is made with the patient bending backward or straining. Symptoms attributable to the hernia are a sharp pain well localized to the hernial ring or a deep, boring, aching pain aggravated by eating or bending backward.

The authors emphasize the importance of careful roentgen study of the stomach, gallbladder, and colon before operation is undertaken for epigastric hernia, and exploration of the abdomen for associated lesions when repair is undertaken.

One table, presenting details of the 76 cases.

R. DATZMAN, M.D.
Indiana University

THE DIGESTIVE SYSTEM

Use of CO_2 and Air as Antispasmodics. Paul Cave. Brit. J. Radiol. **22:** 216–223, April 1949.

The use of air as a contrast medium is well established. Inflation of the gastro-intestinal tract with air or carbon dioxide is often useful also in relaxing spasm, and thus eliminating it as a cause of narrowing. The technic is easy: only a Seidlitz powder is required.

For esophageal studies the patient is screened to locate the site of narrowing and given enough fluid barium to fill the lower third. The first half of the Seidlitz powder is then given in a small quantity of water and then the second powder, with instructions to drink quickly. Screening must be done immediately, as the resulting relaxation may be rapid. This procedure is particularly useful in achalasia of the cardia. It is also valuable in organic strictures. When not enough barium will pass to demonstrate the length of the lesion, distention with gas will often cause sufficient relaxation for complete visualization.

In the stomach the technic is similar, the only difference being that the powder may be mixed with the barium suspension. If it is desired to inflate the antrum, the patient should be placed in the left oblique supine position. Pyloric and prepyloric incisura will be relaxed, giving much clearer visualization of any lesion present. In addition, a double-contrast effect is obtained. Doubtful contours of the greater and lesser curvatures may also be investigated advantageously by this technic.

In the colon, air inflation resolves doubt as to the cause of narrowing in a shorter time than is otherwise required.

Seventeen roentgenograms.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Plummer-Vinson Syndrome. C. Bonorino Udaondo, H. Resano, and V. D'Alotto. Prensa méd. argent. **36:** 257–261, Feb. 11, 1949. (In Spanish)

In 1912 Plummer called attention to a certain form of dysphagia characterized by spasm of the upper portion of the esophagus, of a hysterical nature. Vinson, in 1922, made radiologic and esophagoscopic study of 69 such cases and was unable to demonstrate any organic lesion. In most instances the dysphagia was the initial symptom and there was secondary anemia, although in certain cases this latter symptom appeared first. As the process was prolonged, irreversible changes occurred in the mucosa, including membranous bands projecting from the anterior wall of the lumen or in some cases completely surrounding it.

The authors report a series of 11 cases, the majority of the patients being women between forty and sixty years of age. The dysphagia appeared suddenly in 4 cases; it was of gradual development in others. Hypochromic anemia was present in the majority of cases. Associated findings were atrophy of the lingual papilla, glossitis, cheilitis, koilonychia, loss of weight, and achlorhydria.

The radiographic study is difficult because of the necessity of making very short exposures during the swallowing of the opaque material. The picture is typical, showing a more or less marked stricture at the level of the sixth and seventh cervical vertebrae or cricoid cartilage. This stricture has smooth, regular borders and is often accompanied by one or two folds of membrane which cause incisurae of the esophagus in the narrowed zone. These are best seen in the lateral projection, presenting a depth of 5 or 6 cm. They are single and localized most often in the right anterior wall. In two of the authors' cases there were two similar formations separated by a distance of 1.0 cm.

Thirteen roentgenograms; 1 table.

JAMES T. CASE, M.D.
Chicago, Ill.

A Case of Carcinosarcoma of the Esophagus. Arthur Purdy Stout, George H. Humphreys, II, and Louis A. Rottenberg. Am. J. Roentgenol. **61:** 461–469, April 1949.

This is a report of a single case of carcinosarcoma of the esophagus, with a review and tabulation of the few similar cases from the literature.

The patient, a 46-year-old white female, had a pedunculated tumor on the anterior wall of the lower half of the esophagus. A polypoid filling defect was apparent after a barium swallow. A diagnosis of carcinoma was made and the lower third of the esophagus was resected. Subsequently mediastinal metastases became evident. Removal of these was incomplete and death ensued after a few months. Autopsy showed a mass of tumor filling the upper mediastinum and invading the esophagus, with metastases in the upper mediastinal and right lower cervical lymph nodes. The fleshy tumor showed masses of undifferentiated epithelial cells, most of which were found at the base, but the major portion of the growth had a sarcomatous aspect. Microscopically the metastatic tumor reproduced the sarcomatous elements of the primary growth.

Speculation about the cellular origin of the tumor is offered without conclusions.

Four roentgenograms; 3 photomicrographs; 2 photographs.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital of Cleveland

The Gastric Rugae. R. P. O'Bannon. Texas State J. Med. **45:** 210–213, April 1949.

There is a wide normal variation of rugal folds not only in different patients, but also in the same patient, depending upon the degree of distention of the stomach, amount of contrast medium used, and the degree of motility of the mucosa. The rugal folds of the fundus of the stomach are generally coarse and thick and tend to be moderately whorled. Occasionally they form an irregular lacy pattern with wide variation in their arrangement. In the mid-portion of the stomach, the markings are usually thinner and are parallel with the long axis of the stomach. At times they have an oblique course and may assume a scalloped appearance. In the pyloric end, the markings tend to be finer and usually run parallel with the long axis of the stomach. On rare occasions, the rugae in this portion of the stomach lie at right angles to the long axis of the stomach. This has been attributed to the movement of mucosa over submucosa. The appearance of the gastric rugae is no index of the acid content of the stomach.

The author's technic for demonstration of the gastric rugae is as follows: A small quantity of a thick adhesive barium mixture is given to the patient while he is in the erect posture. He is then instructed to lie on his right side, then on his abdomen, etc., until the mixture is distributed evenly over the inner wall of the stomach. In certain patients, the stomach may be small, with mucosal folds not well demonstrated. Under such conditions, the administration of about 10 grains of sodium bicarbonate and 5 grains of tartaric acid may render the rugae more visible.

In the common type of gastric ulcer, the crater is easily demonstrated as a pool of barium surrounded by a ring-like zone of transparency, with the rugae radiating out from the margins of the crater. This demonstration may be superior to a compression film with a large quantity of barium.

In the presence of sclerosing or extensive infiltrating malignant lesions, the mucosal folds are absent in the involved area and there may be marginal deformity. Localized cancers usually destroy the mucosal folds in the involved area and a definite line of normal to broken or disturbed rugae may be demonstrated. Barium frequently pools in an area of ulceration, and then rugae may be demonstrable extending to the margin of the ulcer. Small masses are clearly visualized as radiolucent areas surrounded by a ring-like zone of barium.

Demonstration of the rugal markings about a gastroenterostomy opening is often difficult, even under favorable conditions. A small amount of barium usually demonstrates the pattern satisfactorily. In the presence of a gastrojejunal ulcer the crater is nearly always visible and a puckered rugal pattern about the ulcer crater is frequently demonstrated.

Infrequently a small quantity of the barium mixture may pass through the pylorus and demonstrate the mucosal pattern of the duodenal cap. In this manner a duodenal ulcer crater with radiating mucosal folds may be visualized.

Four roentgenograms.

R. L. MASON, M.D.
Cleveland Clinic Foundation

Mass Roentgenological Survey of the Gastrointestinal Tract to Detect Cancer of the Stomach. Sherwood Moore. Am. J. Roentgenol. **61:** 470–474, April 1949.

This is a short critique of mass roentgenologic survey to detect gastric cancer. The author points out some of the shortcomings of mass surveys in general. In particular, by analysis of 30,985 examinations of the gastro-intestinal tract done by the usual roentgenoscopic, spot film, and radiographic method, the deduction is made that the incidence of cancer of the stomach has been over-emphasized in comparison with the frequency of cancer elsewhere in the gastro-intestinal tract and of the body in general. In this particular study, a diagnosis of carcinoma was made in 1,352 cases; of carcinoma of the stomach in 619.

Evaluation of the results of these roentgen examinations of the gastro-intestinal tract was encouraging in that a high percentage of the diagnoses were confirmed.

The author concludes that the stomach will not lend itself to mass roentgenologic surveys with any degree of success because of the time and labor required and the exposure risk involved. Present accepted methods of radiologic examination are highly efficient and "gastric cancer of the one type which seems to be suitable for detection by mass survey methods comprises but a small part of the malignancy problem, and even a relatively small part of the incidence of gastro-intestinal cancer."

Three charts.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital of Cleveland

Examination of the Stomach in the Supine Position. Enrico Benassi. Radiol. med. (Milan) **35:** 291–296, April 1949. (In Italian).

A case is presented in which ulcer of the lesser curvature was beautifully demonstrated when the body of the stomach became filled with air after the gastric air bubble was shifted by placing the patient in the supine position. This interesting observation prompts the author to advocate the use of the supine position as a routine in gastric examinations.

Eleven roentgenograms.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Gastro-Intestinal Food Hypersensitivity: Roentgenographic Demonstration. Edward J. Tallant, Hugh A. O'Neill, Frederick Urbach, and Alison Howe Price. Am. J. Digest. Dis. **16:** 140–150, April 1949.

A small bowel study of a group of patients who were hypersensitive to certain foods was done with the purpose of discovering whether there were consistent roentgenographic changes when an allergic individual was fed an allergen, whether similar changes occurred in patients who were not hypersensitive, and finally whether a roentgenographic procedure could be devised to study individuals with food allergy.

For this study, 12 patients were taken who had a history and clinical symptoms of food hypersensitivity, 8 non-allergic patients as a control, and 5 patients with cutaneous manifestations of food hypersensitivity but without clinical evidence of gastro-intestinal disturbance. All were instructed to fast from midnight before the morning of the examination. In the first test, each patient was given 240 c.c. of a mixture of equal parts of barium and water and films were taken one, two, and six hours after ingestion. A second test was given five or more days later, when the allergen to be studied was mixed with the barium and water.

In the first series, no symptoms occurred in any of the patients. The emptying time of the stomach was from one to six hours.

In the test using the allergen barium mixture, none of the control series complained of discomfort and none of those showing cutaneous hypersensitivity suffered gastro-intestinal discomfort, although cutaneous manifestations were generally evident. In the 12 with gastro-intestinal allergy, abdominal pain, nausea, and diarrhea were common complaints. There was, in general, a slower emptying time of the stomach and the most marked changes were in the lower small bowel, where numerous areas of narrowing occurred. Segmentation and scattering of the barium was present in all but two cases in this group.

It is believed that the demonstration of roentgen changes in the small bowel serves as an objective method applicable to the study of disease caused by hypersensitivity of the gastro-intestinal tract, that it may be used as an aid in the diagnosis of intestinal food hypersensitivity and the determination of the specific allergen, and that it may be helpful to evaluate impartially the efficacy of treatment.

Thirty roentgenograms; 3 tables.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Clinical Aspects of Prolapsed Gastric Mucosa. Francis W. Wilson and W. H. Granger. Am. J. Digest. Dis. **16:** 129–131, April 1949.

Prolapse of the gastric mucosa through the pyloric canal occurs infrequently. The authors found the incidence to be 0.24 per cent of 10,500 general admissions (Veterans Administration Hospital, McKinney, Texas) and 1 per cent of 2,511 roentgenologic studies of the upper gastro-intestinal tract.

The cause of gastric mucosal prolapse is not known. Low-grade inflammation with hyperplasia or hyperperistalsis forcing the mucosa through the pylorus may play a role. There is also a possibility of a structural defect which allows a loosening of the attachment of the muscularis from the mucosa.

The symptoms are those of dyspepsia relieved by food, but with absence of night pain. Vomiting and hemorrhage occur, but not invariably. Diet and antispasmodics afford the most relief. Antacids are usually ineffective.

The condition can be diagnosed only by x-ray examination. It is manifested by a rounded deformity in the base of the duodenal bulb. The mucosal folds may be seen extending through the pylorus into the cap.

The condition must be differentiated from ulcer of the duodenum, ulcer of the pylorus, and duodenal polyp. In the case of a duodenal polyp, no rugae are seen to cross the pylorus. Ulcers of the pylorus or cap are more deforming and do not fill the duodenum with a mass.

Two roentgenograms. JOSEPH T. DANZER, M.D.
Oil City, Penna.

A Preliminary Report on the Advantages of a Small Stoma in Partial Gastrectomy for Ulcer. H. W. Porter and Z. B. Claman. Ann. Surg. **129:** 417–428, April 1949.

The authors combined a small (2.5 cm.) stoma with the Hofmeister-Finsterer operation in a series of 118 subtotal gastrectomies for ulcer. They assumed that a sphincter-like action at the gastro-jejunal stoma would increase the quantitative emptying time of the partially resected stomach (*i.e.*, the period required for the fluid level in the gastric remnant to disappear after a barium meal), though the conclusions of others had been that the size of the stoma had nothing to do with the rate of emptying.

The Hofmeister-Finsterer operation is said to prevent leakage at the upper end of the anastomosis and to prevent backflow of gastric contents into the proximal jejunal loop and subsequent leakage at the duodenal stump. The small stoma introduced by the authors prevented bulging of the jejunum (which is thought by some to be responsible for much postprandial discomfort), and also lowered the risk of hemorrhage, since the length of raw edges of the stoma was reduced. The quantitative emptying time averaged fifty-eight minutes in the 40 cases in which it was studied, as compared to the twenty-minute emptying time in other gastrectomies studied by Vitkin. Eighty-eight per cent of the cases demonstrated a sphincter-like action of the stoma, roentgenologically, within six weeks of the operation, as opposed to 7 per cent of a series of gastrectomies of the Polya type examined gastroscopically by Schindler. This sphincter-like effect produced rapid dilatation of the remainder of the stomach to an almost normal volume and prevented jejunitis by allowing only a little food to come in contact with the jejunum at any given time.

The increased emptying time and the prevention of jejunal bulging encouraged a more rapid resumption of a normal diet, thereby hastening convalescence.

It was also found that only 5 of the 118 cases suffered from a persistent dumping syndrome as opposed to 35 per cent of patients with gastrectomies of various types reported by Gilbert and Dunlop.

Arguments against the small stoma are based on the assumption that it would increase the likelihood of stomal ulceration and that obstruction might later occur at the stoma. The authors claim that an adequate resection will prevent the former, and that the latter has not occurred in any of their cases.

Ten roentgenograms and two line drawings.

HARRISON SHAPIRO, M.D.
Mt. Sinai Hospital of Cleveland

Benign Nonepithelial Tumors of the Stomach. Jacob Rabinovitch, David Grayzel, Alfred J. Swyer, and Bernard Pines. Arch. Surg. **58:** 529–538, April 1949.

Of 20 cases of benign non-epithelial tumors of the stomach seen at the Jewish Hospital, Brooklyn, 12 were leiomyomata, 5 fibromata, 1 a neurofibroma, and 2 lipomata. Diagnostic criteria are not definite, and symptoms were inconstant, abdominal pain of variable character being the most common. A palpable mass was rare. There was no notable sex predilection, and patients in the fourth decade were most commonly affected. The tumors were found incidentally at necropsy or operation in 17 patients; in 3, the neurofibroma and 2 leiomyomata, symptoms were due to the tumor. The histology of the tumors is discussed.

Four photomicrographs. LEWIS G. JACOBS, M.D.
Oakland, Calif.

Carcinoid Tumor (Argentaffinoma) of the Stomach. C. Wilmer Wirts and Robert L. Breckenridge. Gastroenterology **12:** 682–689, April 1949.

The authors describe a case of a carcinoid tumor (argentaffinoma) of the stomach which apparently represents the fifteenth recorded instance of this type of growth in the stomach, and the sixth to produce signs and symptoms leading to operation and diagnosis. In the 9 other recorded cases, the tumors were found at necropsy.

The diagnosis of these tumors on the basis of history and physical examination is practically impossible. Symptoms are those usually associated with gastric neoplasms. X-ray and gastroscopic examination are the best means of determining the presence, location, and extent of the lesion, as well as the presence of ulceration and bleeding, but differential diagnosis depends on histologic study following operation. Frequently multiple tumors are present. Malignant change is considered to occur in about 30 per cent of all carcinoid tumors; they metastasize slowly, and prognosis is generally favorable. Treatment is surgical.

A brief review of the literature and discussion with a case summary are presented. Reproductions of a roentgenogram, the gross and microscopic appearance of the tumor, and an artist's drawing of the gastroscopic findings are included.

HERBERT D. KERMAN, M.D.
University of Louisville

Trichobezoar. A. M. Nussey and A. R. Leask. Brit. J. Surg. **36:** 408–410, April 1949.

A case of trichobezoar with clinical symptoms simulating colitis, recurrent diarrhea, moderate hypochromic anemia, and weight loss is described. Noted at clinical examination was a hard and crepitant mass, with a feeling similar to that encountered in subcutaneous emphysema. The mass occupied the upper left abdominal quadrant and seemed to displace the left leaf of the diaphragm upward. A plain film of the abdomen revealed the splenic flexure of the colon to be displaced downward. A definite opacity of uneven density outlined clearly the contours of the stomach filled with the tumor.

The literature on the subject is reviewed and other reported cases are compared with the authors'. The crepitus noted in this case is particularly emphasized. It is felt that, if looked for, crepitus would be found more frequently in such cases and would thus be of considerable diagnostic value.

One roentgenogram; 1 photograph.

F. R. MCCREA, M.D.
Indiana University

Multiple Lipomas of the Stomach and Duodenum. N. W. Fawcett, V. L. Bolton, and E. F. Geever. Ann. Surg. **129:** 524–527, April 1949.

A case is presented of a 36-year-old white male with multiple lipomata of the stomach and duodenum recognized after surgical resection necessitated by recent gastro-intestinal hemorrhage. Roentgen evidence of smooth filling defects in the prepyloric portion of the stomach and in the second portion of the duodenum had been described. The gastric tumor and one of the duodenal tumors were intramural. The third was a pedunculated, ulcerated tumor extending from the second into the third portion of the duodenum.

Lipomata constitute less than 0.06 per cent of surgically treated gastric tumors. They are usually symptomless. Occasionally one may ulcerate and bleed, as in the case presented. A pedunculated tumor may cause intussusception.

Radiographically lipomata produce smooth, well demarcated, rounded filling defects. Obliteration of mucosal pattern, but with little if any disturbance of peristalsis, is observed. The mass moves with the stomach and does not displace it.

One roentgenogram; 1 photograph.

HARRISON SHAPIRO, M.D.
Mt. Sinai Hospital of Cleveland

Lymphosarcoma of the Duodenum. Report of a Case; Review of the Literature. Murray M. Copeland and D. James Greiner. Arch. Surg. **58:** 511–528, April 1949.

A case of reticulum-cell lymphosarcoma of the third portion of the duodenum, with dilatation and subacute perforation is reported. Stenosis of the jejunum distally and involvement of the pancreas and regional lymph nodes had developed. The clinical, radiological, and operative findings failed to give a correct diagnosis, and the true state was not discovered until necropsy. A brief general review of the recent literature follows, with an approving citation of the views of Weber, Kirklin, and Pugh (Am. J. Roentgenol. **48:** 27, 1942) that the roentgenologic diagnosis of this condition cannot be improved, since there is no characteristic picture to distinguish it from other growths.

Seven illustrations, including 2 roentgenograms.

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Spontaneous Paralytic Ileus. W. B. Roantree. Brit. J. Surg. **36:** 352–359, April 1949.

A type of paralytic ileus is discussed which has not previously been described. This syndrome is seen in Mysore State, South India, and is recognized there as a definite clinical entity.

A series of 33 cases is reported, of which 12 were proved by operation. The history is that of gradual onset of pain, moderately severe and poorly localized, in a previously healthy patient. This is followed in one to three hours by a feeling of fullness and progressive distention. Vomiting occurs early and may be severe.

The temperature is subnormal and the pulse slow to normal and of poor quality. Distention is always present; bowel sounds occur in the early cases but may be absent late in the disease. Only deep unlocalized tenderness is noted, and no rigidity.

Flat plates of the abdomen are taken to establish the diagnosis and check progress. Typical small bowel obstruction signs are noted. No mention of gas in the large bowel is made, and pathologic findings show involvement of only the small gut. This was regional or general, in some cases extending to within 6 inches of the cecum. Operation and autopsy findings by the author and others in the Mysore State rule out organic obstruction and other etiologic agents.

In differential diagnosis the chief difficulty is in exclusion of a perforated typhoid ulcer with peritonitis. Late cases with no bowel sounds and disturbed fluid balance are also confusing.

Treatment is conservative and designed to relieve distention and restore fluid balance. The mortality is approximately 25 per cent in patients who present themselves early and have demonstrable bowel sounds; it may be as high as 50 per cent in later cases without bowel sounds.

The etiology is thought to be associated with ingestion of the millet ragi which has spoiled by being stored underground.

The dietary factor in the etiology of ileus has been considered by other authors and this report is presented as another example.

Nine roentgenograms. J. SCOTT, M.D.
Indiana University

Diagnosis of Intestinal Obstruction in the Newborn. A Review of the Literature with a Report of Eight Additional Cases. Everett Carlson, Albert G. Clark, and Paul M. Walstad. California Med. **70:** 240–243, April 1949.

Among 8,305 live births over a five-year period, the authors found 7 cases of intestinal obstruction developing during the first five days of life. Four of these were the result of single or multiple atresia of the bowel and 3 of volvulus. As a rule the general clinical condition of the patient was strikingly normal, so that in some instances the diagnosis was not at first suspected. The most common sites of atresia are the lower ileum and duodenum.

Persistent vomiting in the newborn and failure to pass a normal stool should lead one to be suspicious of an anomaly of the bowel. To be differentiated are vomiting due to pyloric stenosis, which is seldom seen before two weeks; vomiting due to inspissated meconium, resulting from pancreatic achylia from stenosis of the pancreatic duct; adynamic or paralytic ileus, which is exceedingly rare in the newborn.

The character of the stool may be misleading. All but one of the patients with atresia passed stools, but none of those with volvulus. Distention is a striking feature in most instances of volvulus.

The most useful aid in intestinal obstruction of the newborn is the x-ray examination. The infant abdomen differs from the adult abdomen in that there is generally air present in the small intestine up to the age of two years. Therefore, the absence of intestinal gas shadows is suggestive of obstruction.

In a case of duodenal atresia observed by the authors the duodenum was considerably dilated with gas, whereas there was no evidence of gas in the remaining intestinal tract. In a case of multiple atresia the x-ray appearance was that of a high intestinal obstruction. In volvulus gas may or may not be visualized in the small intestine. It is believed that non-passage of gas is dependent upon an associated malrotation of the midgut with resultant obstruction of the duodenum.

Treatment is surgical, and preoperative preparation is of paramount importance.

Ten illustrations, including 8 roentgenograms; 1 table. MAURICE D. SACHS, M.D.
Cleveland, Ohio

Jejuno-Ileal Diverticula. A Review of the Literature and Case Reports. Randolph E. Watts and Samuel M. Ramer. Rocky Mountain M. J. **46:** 301–304, April 1949.

Jejuno-ileal diverticula are either congenital or acquired; the former contain all the anatomical layers of the small bowel, whereas the latter consist only of mucosa and serosa and are found at the mesenteric border. These diverticula are found more frequently at autopsy than by roentgenologic examination. Most are asymptomatic, though in some cases there are ill-defined abdominal complaints.

According to Case (1920), the diagnosis will be based on finding in the erect film one or more persisting barium shadows, hemispherical in outline, each hemispherical shadow presenting a fluid level surmounted by gas. The authors believe, however, that many diverticula can be found with the patient in the horizontal position. Sometimes diverticula are not visualized but are found at surgery or autopsy.

Three illustrative cases are presented, with 2 roentgenograms. PAUL W. ROMAN, M.D.
Baltimore, Md.

Diagnosis of Chronic Recurrent Pancreatitis. W. Grafton Hersperger. South. M. J. **42:** 289–295, April 1949.

The author emphasizes the importance of chronic recurrent pancreatitis in the differential diagnosis of repeated attacks of abdominal pain for which the explanation is not otherwise satisfactorily determined.

Thirty-three cases form the basis of this paper. In this series there were 23 males and 10 females, and the average age at onset was thirty-eight years. The outstanding clinical features of the disease are repeated attacks of epigastric or periumbilical pain which may radiate to the right or left costal margin, either scapula, the upper lumbar region or costovertebral areas, especially the left; variable duration of attacks for a few hours to several days; some degree of flatulence; vomiting (50 per cent of cases); jaundice (30 to 50 per cent of cases) and loss of weight. Chronic alcoholism is present in 50 per cent of cases. On physical examination there is no single finding giving a clue to the nature of the process. During the active phase the serum lipase or amylase determinations are the most valuable laboratory procedures, with the serum lipase examination possibly giving the highest percentage of accuracy. Over 50 per cent of this series of cases showed evidence of disturbed carbohydrate metabolism, including diabetes mellitus, hyperglycemia, and glycosuria.

Roentgen examination reveals calcification in the region of the pancreas in 40 to 50 per cent of cases. Gastro-intestinal series demonstrate disturbed motility and pressure defects. To be differentiated are biliary tract disease, peptic ulcer, ruptured viscus, intermittent

intestinal obstruction, urinary tract lesions, coronary thrombosis, pancreatic carcinoma, and non-tropical sprue (when steatorrhea is present).

The first requirement in the diagnosis of chronic recurrent pancreatitis is that the physician be familiar with the possible manifestations of the disease and suspect it, along with other possible disorders. It should especially be considered if suitable studies fail to reveal disease of adjacent organs when the history is consistent. Alcoholism and disturbed carbohydrate metabolism are strong supportive evidence. Demonstration of pancreatic calcification is also suggestive of this disease. Finally, the disease is most accurately demonstrated by elevation of the serum amylase or lipase values during an exacerbation.

Four roentgenograms.

HARVEY J. THOMPSON, JR., M.D.
Jefferson Medical College

Spontaneous Pneumoperitoneum. Walter L. Stilson and Otto J. Neufeld. California Med. **70:** 269–273, April 1949.

Spontaneous pneumoperitoneum is most commonly due to a perforated peptic ulcer. It may occur also as a result of rupture of abdominal viscera from other causes, or may follow laparotomy. Finally, 3 cases have been reported without any assignable cause (see Hinkel: Am. J. Roentgenol. **43:** 377, 1940). The authors report a fourth case of this latter type.

The patient was a woman of 81 years, with abdominal distention and pain of one week duration. X-ray examination revealed free air outlining the peritoneal cavity. No evidence of a ruptured viscus was discovered at operation. The patient recovered.

Examination of a patient with acute disease of the abdomen should include not only a roentgenogram with the patient supine but films made in the left lateral decubitus position and/or upright position to demonstrate free air. The radiologist should be ready and willing to consult with the surgeon at the time of examination. Attention is called to a sign described recently by Rigler (Radiology **37:** 604, 1941) in supine films, namely, the visibility of both the inside and the outside of the intestinal lumen. Another sign in the supine film is the contrast of air against the peritoneal reflections.

In the discussion of this article, Dr. Garland stated that he had seen a case of spontaneous pneumoperitoneum in a female who gave a history of taking vigorous knee-chest position exercises, the assumption being that the air had entered via the fallopian tubes.

Six roentgenograms.

MAURICE D. SACHS, M.D.
Cleveland, Ohio

THE MUSCULOSKELETAL SYSTEM

Osseous Lesions Through Overload on the Normal Skeleton (Experimental Results). E. Rutishauser and G. Majno. Schweiz. med. Wchnschr. **79:** 281–288, April 2, 1949. (In French)

This study is concerned with the lesions produced by mechanical overloading of the skeleton, the prototype of which is the "march fracture." The authors stress the causation of such lesions by an exaggeration of normal forces, as contrasted with the results of an acute traumatism. The experiment which they report consisted in the resection of 1.5 to 5 cm. of the distal radius in dogs, following which immediate weight-bearing was permitted. This produced an abnormally great mechanical strain on the ulna. The animals were sacrificed for histologic study when a fracture appeared or when a lesion had reached its maximum evolution. The lesions were divided into four groups, representing descending degrees of strain: (1) immediate fracture; (2) delayed fracture; (3) hypertrophy with development of zones of disorganization (Umbauzonen); (4) simple hypertrophy without fracture. The results of the study are presented in summary in the authors' Table 2, which has been modified for the purposes of this abstract as follows:

I. Fracture by force
- Onset: Few hours (1–24)
- Symptomatology: Sudden fracture at beginning of overload
- Evolution: That of fracture
- Site: Point of maximum strain
- Diffuse lesion: None
- Local lesion: Fracture in shaft
- Microscopic lesions
  - Periosteum: Secondary reactions
  - Endosteum: Secondary reactions
  - Osteocytes: Secondary necroses

II. Slow fracture
- Onset: Few days (4–11)
- Symptomatology: Sudden fracture during course of overload
- Evolution: Not studied; reports in literature conflicting
- Site: Point of maximum strain
- Diffuse lesion: Osteonecrosis; osteophytosis; osteoid formation
- Local lesion: Transverse fracture, subperiosteal
- Microscopic lesions
  - Periosteum: Osteoid osteophytosis
  - Endosteum: Osteoid osteophytosis
  - Osteocytes: Diffuse primary necrosis, more common near fracture

III. Pathologic hypertrophy with "Umbauzone"
- Onset: Few weeks (5–6)
- Symptomatology: None. X-ray shows hypertrophy traversed by clear line
- Evolution: Progress to fracture if overload is continued
- Site: Point of maximum strain
- Diffuse lesion: Osteonecrosis, fusiform hypertrophy, containing Umbauzone
- Local lesion: Transverse zone of absorption (Umbauzone)
- Microscopic lesions:
  - Periosteum: Diffuse periostitis, absent at site of Umbauzone
  - Endosteum: Diffuse osteosclerosis; spongy at Umbauzone
  - Osteocytes: Diffuse primary necrosis, more common near Umbauzone

IV. Simple hypertrophy
- Onset: Few months (2–6)
- Symptomatology: None. X-ray shows simple hypertrophy
- Evolution: Stabilization
- Site: Point of maximum strain
- Diffuse lesions: Fusiform hypertrophy
- Local lesion: None
- Microscopic lesions:
  - Periosteum: Diffuse periostitis

Endosteum: Diffuse osteosclerosis
Osteocytes: No necrosis
Fourteen figures, including 5 roentgenograms.
LEWIS G. JACOBS, M.D.
Oakland, Calif.

Observations on Bone Lesions in Hodgkin's Disease. P. J. Moir and J. G. Brockis. Brit. J. Surg. **36:** 414–417, April 1949.

A case of Hodgkin's disease with certain unusual features and a brief review of bone lesions in this disease are presented.

Bone lesions in Hodgkin's disease are fairly common. Usually they are destructive, especially in the skull and pelvis, where punched-out areas occur, resembling multiple myeloma. Lesions in long bones are more common at the ends; when the shaft is involved, there may be erosion of the cortex with some expansion and periosteal changes. Occasionally osteoplastic changes are found. The x-ray findings may simulate metastatic cancer, osteogenic sarcoma, bone cyst, or osteomyelitis, as well as multiple myeloma.

These bone lesions probably are metastatic and occur chiefly in the malignant type of Hodgkin's disease, which may closely resemble multiple myeloma in its behavior.

The quick response by the soft-tissue lesions to x-ray therapy and absence of effect on the bones are discussed.

Six illustrations, including 3 roentgenograms.
O. R. RUSSELL, M.D.
Indiana University

Parrot's Syphilitic Pseudoparalysis. Otto Fliegel. Bull. Hosp. Joint Dis. **10:** 86–100, April 1949.

Parrot's syphilitic pseudoparalysis is a special form of congenital syphilis with extensive osseous involvement. The bone ends are enlarged and tender, while the limbs are motionless. The response of the muscles to electrical stimulation is normal, but clinically they are flaccid.

The roentgen signs are those usually seen in congenital syphilis—parallel periostitis, infraction through the metaphyseal area, symmetrical areas of destruction in the metaphyses at the upper ends of the tibiae, serration of the ends of the long bones, and density of the juxta-epiphyseal bone with adjacent osteoporosis.

Besides rickets and scurvy, Erb's palsy, traumatic lesions, and pyogenic infections must be considered in the differential diagnosis. Congenital syphilis is evident at about the fourth week after a normal growth to that time. Neither rickets nor scurvy occur as early. Serologic tests may be negative. X-ray examination is essential, for, though any one of the individual findings may be inconclusive in itself, when interpreted in the light of the clinical picture it may assume diagnostic significance.

The response to antisyphilitic therapy is dramatic.
Twelve roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

A New Method of Demonstration of Ligamentous Changes in Lumbago and Sciatica. F. K. Fischer. Schweiz. med. Wchnschr. **79:** 213–217, March 12, 1949. (In German)

The author reviews the subject of myelography with special reference to technic and sequelae. He notes the inefficiency of gas myelography, the frequent occurrence of arachnoiditis following the use of lipiodol, and the improvement incident to the introduction of pantopaque. He feels that even better studies of the canal and soft tissues are obtained by the use of 20 per cent abrodil (skiodan, sodium mono-iodo methane sulfonate) as originally described by Arnell and Lidström (Acta radiol. **12:** 287, 1931. Abst. in Radiology **17:** 1338, 1931). The 20 per cent solution is hypertonic, 4 per cent being isotonic; this necessitates the use of preliminary spinal anesthesia to avoid the severe cramping pain in the bladder and lower extremities otherwise felt. The duration of the anesthesia is about the same as the excretion time of the drug, which can be seen in the kidneys in thirty minutes. If no anesthesia is used, the cramping pains disappear in about ten minutes, apparently because the drug becomes diluted with spinal fluid.

Some very beautiful myelograms demonstrating soft-tissue changes are reproduced, with a brief case history for each; these give at least a *prima facie* validity to the author's views. The sequelae noted are seldom serious; in over 700 myelograms, 54 patients had various symptoms, including 32 with shock developing in from five minutes to twenty-four hours and 3 with paralysis of the bladder and lower extremities lasting several weeks. No deaths occurred in this group. A discussion of errors in technic is included, especially the use of solutions of excessive concentration. The serious sequelae are attributed to such errors.

Twenty-seven illustrations, including 22 roentgenograms. LEWIS G. JACOBS, M.D.
Oakland, Calif.

Double Contour, Cupping and Spurring in Roentgenograms of Long Bones in Infants. Kurt Glaser. Am. J. Roentgenol. **61:** 482–492, April 1949.

Monthly roentgenograms of 100 healthy, prematurely born infants were studied from birth to eight months of age. A double line in the contour of the long bones of the extremities and a cupped and spurred appearance of the epiphyseal line of the same bones were frequently observed. These changes occurred most frequently in the period from three to six months in premature infants and in the period from two to five months in full-term babies studied for comparison. In the past they have often been misinterpreted as signs of disease.

The explanation for the temporary occurrence of the double line is probably as follows: The over-all lack of calcification during the first few weeks of life prevents visualization of superimposed crests. With increased calcification of prominences during the following months while the bone is still relatively transparent, confusing double contours are seen along the cortex of the long bones. Subsequent progressive calcification of the entire bone decreases the prominence of finer details and causes the disappearance of these findings.

The "cupping and spurring" of the epiphyseal plates is explained on the basis of distortion due to the projection of divergent rays. This metaphyseal distortion also occurs in the age ranges given above, and its disappearance is probably due to the fact that increasing density of calcification in older babies, does not permit penetration of the rays, thereby preventing visualization of a superimposed second shadow.

Histologic examination of sections through bones of infants who showed these findings *in vivo* and who died of unrelated conditions revealed no abnormality. The phenomena disappear without treatment and must be

considered as normal roentgen findings during the period of growth.

Eight roentgenograms; 2 drawings; 2 tables.

HARRISON SHAPIRO, M.D.
Mt. Sinai Hospital of Cleveland

Ossification Centers of the Lower Limb in an Infant of Two Years. J. Poulhès. J. de radiol. et d'électrol. **30:** 124–126, 1949. (In French)

The time of appearance of the ossification centers of the lower extremity was studied in 2,500 children from the time of birth to the age of two years. A graph is presented which shows the percentage of infants developing radiologically visible ossification centers at different points from month to month. The average time of appearance of some of the principal epiphyses are: femoral head, six months; inferior femoral epiphysis, at birth; superior epiphysis of tibia, at birth; inferior epiphysis of tibia, six months; inferior epiphysis of fibula, one year; cuboid, one month; and third cuneiform, four months.

CHARLES NICE, M.D.
University of Minnesota

Congenital Dysplasia of the Hip Joint. Relationship Between Congenital Subluxation and Congenital Dislocation. Vernon L. Hart. J. Bone & Joint Surg. **31-A:** 357–371, April 1949.

The occurrence of a flat, shallow acetabulum during fetal life may result (1) in congenital dislocation of the hip, *i.e.*, complete displacement of the femoral head, (2) in congenital subluxation of the hip, with some contact of the articular surfaces of the femoral head, socket, and limbus, or (3), occasionally, in distortion of the head of the femur with no actual displacement. Congenital dysplasia is always bilateral in early fetal life, so that unilateral postnatal dysplasia must denote spontaneous healing of the opposite hip.

Not all congenital dislocations and subluxations of the hip are the result of primary dysplasia or maldevelopment of the acetabulum, and not all are to be explained on the basis of a single mechanism. The author limits himself to discussion of displacements due to an osseous and cartilaginous defect or to aplasia of the superior and posterior supports or buttresses for the head of the femur. He seeks to establish a common etiological relationship between subluxation and dislocation and offers evidence from the literature, from clinical and roentgenologic observations, from genetic, embryologic, and anthropologic studies, and from other sources. The most convincing evidence of a common etiology for the two entities is the high incidence of coexistence of dysplasia with dislocation on one side and dysplasia with subluxation on the other.

McCarroll and Crego (J. Bone & Joint Surg. **21:** 648, 1939) are quoted as recognizing three types of dislocation, posterior, upward, and anterior, but the authors point out that the last of these is actually superior, with anteversion of the femoral neck. Often dysplasia is not noted until late in childhood, when the patient complains of hip pain and fatigue, or in adolescence or early adult life, when the roentgenogram will reveal a flat dysplastic socket with disturbance of Shenton's line. Traumatic osteoarthritis may develop in these hips because of their dysplastic incongruity and malformation.

Fourteen roentgenograms.

R. A. HAYS, M.D.
Cleveland Clinic Foundation

Intra-Uterine Fractures of the Tibia and Fibula: Report of a Case with Correction by Osteotomy and Plating. George H. Dawson, Jr. J. Bone & Joint Surg. **31-A:** 406–408, April 1949.

Intra-uterine fractures may occur as a result (1) of trauma, with direct injury to the fetus; (2) of amniotic snaring off; (3) of diseases, as osteogenesis imperfecta, chondrodystrophies, or syphilis. Obstetrical fractures are ruled out by roentgenograms made on the first or second day, showing either healing of normal bone or evidence of some other bone lesion. If repair of a bone fracture is evident, intra-uterine fracture is the diagnosis.

The author reports a case of intra-uterine fracture of the left tibia and fibula with osteotomy for correction of bowing at the age of twelve weeks.

Six roentgenograms; 2 photographs.

E. HAMPTON BRYSON, M.D.
Cleveland Clinic Foundation

Some Obstetrical Injuries to the Long Bones. Spencer T. Snedecor and Harrison B. Wilson. J. Bone & Joint Surg. **31-A:** 378–384, April 1949.

Trauma to the long bones is common, especially in breech deliveries. The greatest injury is at the epiphyses. The severe torsion of a hurried breech delivery may cause the bones of the lower extremities to give way at their weakest point, the epiphyses. The periosteum is stripped off in the process with a fair amount of hemorrhage.

The clinical picture is one of tender swollen legs on the day after delivery. Roentgenograms on the second and third day are negative, but as healing takes place, calcium is deposited in the hemorrhagic nidus and by the seventh day a roentgenogram will demonstrate dense shadows of calcification around the epiphysis or subperiostially, or both.

The prognosis is excellent in the majority of cases. The roentgenogram reverts to normal within three or four months.

Eleven case histories are included, with 16 roentgenograms.

R. A. HAYS, M.D.
Cleveland Clinic Foundation

Myositis Ossificans in Paraplegics. Leo Frederick Miller and Colman J. O'Neill. J. Bone & Joint Surg. **31-A:** 283–294, April 1949.

Myositis ossificans has been classified as of three types: (1) myositis ossificans progressiva, which begins soon after birth; (2) myositis ossificans circumscripta resulting from local trauma, the most common type, occurring three to five weeks following an injury; (3) myositis ossificans circumscripta without history of trauma, which is the group discussed in this paper.

Myositis ossificans in association with cord lesions was first described by Déjèrine in France after World War I. The most common sites are in the hip joint region, upper third of the thigh and the knees. The authors found the ossification to be chiefly around the hips. They tabulate their observations in 12 cases. The blood chemistry was normal. Roentgenograms revealed dense calcifications about the hip joints. The calcification is trabeculated and extends anteriorly from the anterior superior iliac spine over the hip joint and along the rectus femoris. It may descend medially from the iliopubic rami into the abductor muscle group.

Most investigators believe that metaplasia in the

muscle bundles accounts for the formation of the calcifications seen in paraplegics.

Eleven roentgenograms; 5 photomicrographs; 1 table.

R. A. HAYS, M.D.
Cleveland Clinic Foundation

Spondylitis, Pathological Ossification, and Calcification Associated with Spinal-Cord Injury. Daniel J. Abramson and Samuel Kamberg. J. Bone & Joint Surg. **31-A:** 275–283, April 1949.

The roentgen findings in 35 patients with paraplegia are reported. Twenty-four of the group had complete transverse lesions; 6 had partial lesions above the first lumbar segment, and 5 had lesions of the cauda equina. In general, the changes in patients with lesions below the first lumbar vertebra and partial lesions were not significant. Those in the group with complete transverse lesions above the first lumbar segment were more striking and represented a more advanced stage of the disease process. The changes included osteoporosis of vertebral bodies, sclerosis in the region of the sacroiliac joints and apophyseal joints, narrowing and fusion of these joints, soft-tissue calcifications, and occasionally periosteal proliferation of a lacy type about the heads of the femora and ischia.

The changes often simulate the findings in rheumatoid spondylitis but in the authors' series no involvement of the lumbar region was seen, regardless of the level of the cord injury.

Several theories and explanations for the above changes are given. They resolve themselves into changes in circulation, *p*H of the blood and tissues, and the calcium, phosphorus, and protein ratios.

Eight roentgenograms.

R. A. HAYS, M.D.
Cleveland Clinic Foundation

Rheumatoid Spondylitis: Observations on the Incidence and Response to Therapy Among Veterans of the Recent War. Elam C. Toone, Jr. Ann. Int. Med. **30:** 733–739, April 1949.

This report deals with a series of 29 cases of rheumatoid spondylitis observed over a period of fifteen months on the wards of a General Veterans Administration Hospital.

Rheumatoid spondylitis is a disease of unknown etiology capable of producing severe crippling deformities and is particularly prone to affect otherwise healthy young males. Pain is the universal complaint. At the onset it is usually localized to the lower back, is often sharp and stabbing in character, intermittent in occurrence, and tending to be more severe at night. Secondary symptoms such as insomnia, anorexia, and weight loss are common.

There is a loss of the lumbar curve in most instances with definite spasm of the paravertebral muscle groups. Movement of the back in all directions is guarded and restricted and on attempted forward flexion the lumbar spine remains rigid and flat. More advanced cases show evidence of dorsal kyphosis, scoliosis, a tilted pelvis or a "frozen" depressed shoulder. The gait is always abnormal.

There are no laboratory findings of a pathognomonic nature. An increased sedimentation rate is probably the most helpful. Roentgenographic changes are probably the most valuable single finding in the diagnosis of rheumatoid spondylitis. Involvement of the sacroiliac joints may vary from an early narrowing of the joint space with irregular bone proliferation and osteoporosis of the adjacent bone to complete ankylosis. Each of the 29 cases in this series showed bilateral involvement of these joints. The *apophyseal joints* are more difficult to visualize and special oblique views are necessary to demonstrate changes, which may vary from narrowing of the joint space to complete ankylosis. Examination of these joints was done only rarely in this series of cases and can only be said to have furnished confirmatory evidence. Calcification of the *anterior* and *lateral ligaments* and of the *ligamentum flavum* is a common finding and may appear relatively early in the disease. Fifteen cases showed evidence of calcification in one or more of these ligaments.

Treatment of this disease is directed to the following objectives: (1) general care of the patient, (2) relief of pain, and (3) prevention of spinal deformities. Roentgen therapy (190 kv.) directed over the back has proved to be the most effective means of controlling pain. The technic used by the authors is a modification of that advocated by Smyth, Freyberg, and Lampe in 1941 (J.A.M.A. **117:** 826, 1941). The spine is divided into four areas and treatments are given biweekly until each area selected for treatment has received 600 r. The average patient receives a total of three such courses at intervals of six to eight weeks, after which further treatment is withheld for six months unless a relapse occurs.

The mode of action of roentgen rays in relieving pain in rheumatoid spondylitis is not understood. Apparently its greatest beneficial effect results from its ability to lessen muscle spasm.

Of 28 patients who received roentgen therapy, 19 (67.9 per cent) reported definite relief of pain. In 7 of these the results were excellent, with no discomfort while at rest or on moderate use of the back. Nineteen patients returned for two or more series of therapy, 2 receiving four courses, 10 receiving three, and 7 receiving two. So far as the relief of stiffness is concerned the results are not impressive.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Rheumatoid (Marie-Strümpell) Spondylitis. Technique of Examination and Importance of the Costal Joints. A. Justin Williams. California Med. **70:** 257–260, April 1949.

Rheumatoid spondylitis is a chronic disease which involves the smaller joints of the spine and ribs and of the sacroiliacs and tends to progress to spinal ankylosis. In a detailed study of 500 cases the earliest roentgen evidence of joint involvement was found in one or more of the costal or apophyseal joints. In order best to reveal the costal joints, the author advises an anterior-posterior projection with the tube angled 20 degrees cephalad and centered between the fifth and seventh dorsal vertebrae. The conventional 90-degree antero-posterior projection of the thoracic spine does not outline these small joints well and may lead to inaccuracies of interpretation in any but advanced cases.

In a series of 151 cases of rheumatoid spondylitis, the sexes were found to be equally represented. In all these cases the diagnosis was made by clinical and radiographic studies combined, in none by radiography alone. Females are less prone to sacroiliac changes and much less commonly reach the spondylitic stage, which accounts, in part at least, for the frequently reported predominance of the disease in males.

In all cases of vague aches and pains in the back and extremities, the author believes that determinations of the sedimentation rate and roentgenograms of the back, with special emphasis on the costal and apophyseal joints, should be made.

Five figures, including 4 roentgenograms.

MAURICE D. SACHS, M.D.
Cleveland, Ohio

Radiological Aspects of Vertebral Syphilis. (Report of Three Cases.) Aubry, Tillier, Portier, and Béranger. J. de radiol. et d'électrol. **30:** 195–198, 1949. (In French)

Syphilis of the vertebral column is rarely seen. Three cases are presented. Sclerosing and destructive changes, as well as spur formation, may occur, so that tuberculous or other forms of osteoarthroses may be simulated. Improvement after antisyphilitic therapy is a valuable aid in diagnosis.

Five roentgenograms; 5 drawings.

CHARLES NICE, M.D.
University of Minnesota

Eosinophilic Granuloma of Rib. Report of a Case Observed for Eight Years. Austin R. Grant, Reginald K. House, and Walter B. Crandell. New England J. Med. **240:** 541–543, April 7, 1949.

It is a common impression that eosinophilic granuloma is a disease of children and young adults, but several cases in mature individuals have been found.

The authors report a case in a 46-year-old laborer who was admitted to the hospital in 1939 for a herniorrhaphy. A chest film at that time showed a sharply defined non-invasive expansile growth of the left 10th rib. In 1948, at the age of fifty-five years, the patient was again admitted to the hospital complaining of pain over the left 10th rib, and a section of the rib containing the growth was resected. Microscopic examination showed eosinophilic granuloma.

This case report demonstrates that eosinophilic granuloma may occur rather late in life, be relatively quiescent for years, and suddenly produce symptoms.

Two roentgenograms; 1 photomicrograph.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

An Unusual Rib Lesion (Monostotic Fibrous Dysplasia). Ernst Theilkäs. Radiol. clin. **18:** 82–87, March 1949. (In German)

A marked fusiform deformity of the seventh right rib, about 4 cm. wide and 22 cm. long, was seen on a chest film. The patient had no symptoms referable to it. The structure of the rib was coarse with several round or oval defects. The appearance corresponded to that described by Schlumberger, who studied 29 cases of monostotic fibrous dysplasia of the ribs (Mil. Surgeon **99:** 504, 1946. Abst. in Radiology **49:** 518, 1947).

Two roentgenograms.

H. W. HEFKE, M.D.
Milwaukee, Wis.

Tuberculosis of the Bones of the Hip Joint. Charles J. Sutro and Herman Gladstone. Bull. Hosp. Joint Dis. **10:** 20–49, April 1949.

Seventy cases of tuberculosis of the hip joint were studied from the orthopedic point of view, with a number of interesting conclusions on various phases of the subject.

An early roentgen sign of tuberculous involvement in the very young was lateral displacement of the head of the femur, as evidenced by widening of the medial joint space. "Beaking" of the upper edge of the acetabular rim was often seen in cases where the infection was known to originate in the acetabulum. This "beak" sometimes becomes long enough to resemble a bone graft between the innominate bone and femoral neck.

Sequestration was rare in young patients and usually indicated secondary infection. In adults it was more common and was associated with a poor prognosis.

In young patients prolonged immobilization sometimes led to changes in the knee and even the ankle on the affected side. The ligaments and tendons became relaxed, giving rise to instability.

It is stressed that a successful fusion or osteotomy does not mean that all the infection has been eradicated. Once tuberculosis involves the tissues in a joint, that joint will continue, in most cases, to bear histologic evidence of the disease.

When necrosis and caseation are extensive, complications and poor results may be expected. Subtrochanteric osteotomy is best if soft-tissue abscesses are found or if there is extensive atrophy.

In adults the authors believe that conservative measures should be given a longer trial than is the present custom. When surgery is indicated, they recommend osteotomy instead of arthrodesis.

Recurrent pain in an old tuberculous hip in an adult may be due to osteoarthritis rather than reactivation of the infection. In such cases arthrodesis is quite successful.

Nine roentgenograms; 1 photograph; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Spontaneous Sacro-Iliac Obliteration in Patients with Tuberculosis. Alvin S. Isaacson and Walter M. Whitehouse. J. Bone & Joint Surg. **31-A:** 306–311, April 1949.

The authors studied roentgenograms of the spine of 330 patients with tuberculosis and found that 22 had destructive and obliterative lesions of one of the sacroiliac joints. To this they add one other case, to give a series of 23.

Positive proof of a tuberculous etiology was not found in all cases, but the presumptive evidence was high, tubercle bacilli being isolated from some lesion in the body in all but 2 patients. One of these 2 had a primary lesion and in the other the disease process was believed to be due to a widely disseminated pyogenic infection.

In 9 patients partial or complete ankylosis was demonstrable on the initial film. Operative fusion was done in 3 cases, and in 6 spontaneous fusion of the joints occurred while the patient was under observation. The earliest fusion took place four months after the onset of symptoms; the longest interval required was two years.

The authors feel that a program based on one year of conservative therapy should be instituted before operative fusion is contemplated. They are not satisfied with fibrous ankylosis because of the tendency to reactivation.

Seven roentgenograms; 1 table.

R. A. HAYS, M.D.
Cleveland Clinic Foundation

Osteitis Pubis. M. Abrams, I. Sedlezky, and David B. Stearns. New England J. Med. **240:** 637–641, April 21, 1949.

Five cases of osteitis pubis are reported, 2 of which followed retropubic prostatectomy, 2 suprapubic prostatectomy, and 1 abdominoperineal resection for carcinoma of the rectum.

It is the belief of the authors that osteitis pubis is an inflammatory process. Clinically, the patient complains of pain over the pubis that is mild at first but becomes more intense with time. The onset varies from one to three months after operation. The pain radiates to the perineum and down the inner aspects of the thighs. Motion of the lower extremities causes pain, possibly due to the pull of the tendinous attachments to the inflamed periosteum. There is usually a leukocytosis, and the urine is infected.

The most characteristic feature is the appearance of the pelvis on the roentgenogram. The bone edges along the symphysis are usually blurred and there is patchy osteoporosis in the contiguous bone. As the process increases, the symphysis is widened. No sequestration appears. The widening of the symphysis and the definite mobility of the pelvis can be shown by films taken with the weight borne on one extremity and then on the other.

Healing of the process usually requires about two months. The sulfa drugs and the antibiotics have not been found to be of much help, but x-ray therapy was believed to be beneficial in one of the authors' cases.

In the differential diagnosis, a chronic osteomyelitis, metastatic carcinoma, and primary bone sarcoma must be considered.

Five roentgenograms. JOHN B. MCANENY, M.D.
Johnstown, Penna.

Calcification of the Bursae of the Knee. Theodore Norley and William H. Bickel. J. Bone & Joint Surg. **31-A:** 417–420, April 1949.

The more important bursae about the knee are (1) the prepatellar bursa, located anterior to the lower half of the patella, (2) the infrapatellar bursa, between the tibia and the lower portion of the patellar ligament, (3) the superficial pretibial bursa, over the insertion of the patellar ligament, (4) variable bursae situated below and above the collateral ligaments, and (5) numerous and variable popliteal bursae, often communicating with the synovial cavity of the knee. The chief popliteal bursa is the gastrocnemius semi-membranosus.

The mechanism of heterotopic calcification is not known. Watson Jones and Roberts (Brit. J. Surg. **21:** 461, 1934) state that in bone, normal circulation results in normal calcification; increased circulation in decalcification; decreased circulation in increased calcification; and cutting off the blood supply in unchanged calcification.

In the records of the Mayo Clinic, the authors found 8 cases of calcification in various bursae of the knee. All patients complained of progressive pain on motion, swelling, and limited motion. Physical examination usually revealed a tender swelling over the involved bursa. Calcification was not usually suspected until its presence was revealed in the roentgenogram. Of the 8 patients, 4 gave a history of trauma. The calcification involved prepatellar bursae in 2 cases, infrapatellar bursa in 1, bursae over the medial femoral condyle in 4 cases, and bursa over the lateral condyle in 1 case.

Treatment consists of local injection of procaine hydrochloride and needling, or surgical excision.

Five roentgenograms. R. L. MASON, M.D.
Cleveland Clinic Foundation

"A Broken Ankle." George Perkins. Bull. Hosp. Joint Dis. **10:** 4–19, April 1949.

More articles such as this are needed in the literature. While nothing startling is presented, the various types of fracture involving the ankle joint are carefully gone over in detail. Answers to many questions asked by general surgeons and general practitioners who have limited training and experience are given, together with the reasons for the answers.

Accurate replacement of the talus and maintenance of the ankle mortise are stressed. Early restoration of function is believed equally important. A novel but sound suggestion is made with regard to cases in which fixation of the medial malleolus is necessary. The author does not immediately apply a cast but keeps the patient in bed a day or two until a fairly full range of motion is obtained. He feels that this is the optimum time to restore motion instead of after the cast is removed.

Unevenness of the tibial articular surface must be corrected if any more than one-fourth of the weight-bearing surface is involved. If multiple fracture lines involve the weight-bearing surface, it is likely that arthrodesis will be necessary to obtain a painless ankle.

This article should be read in the original by everyone seeing orthopedic roentgenograms.

Eight roentgenograms; 3 drawings.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Sesamoid Bones of the Hands and Feet. Charles A. Hubay. Am. J. Roentgenol. **61:** 493–505, April 1949.

From analysis of a series of 529 roentgenograms of the hand and 570 of the feet, the author concludes that in the adult hand, as a rule, there are five sesamoids. Two of these lie at the metacarpophalangeal joint of the thumb, one at the interphalangeal joint of the thumb, and one each at the metacarpophalangeal joints of the index and little fingers. According to Buehl and Pyle (J. Pediat. **21:** 335, 1942) the average age of ossification of the pollex sesamoids was 10.1 years in females and 12.6 years in males. No significant sex differences were otherwise noted.

In the foot, two sesamoid bones are usually present at the metatarsophalangeal joint of the great toe. Other sesamoids are inconstant.

It is important that bipartition of sesamoids be distinguished from fracture. To make the distinction, the usual criteria for fracture are used, such as irregular serrated margins, evidence of healing, and unilaterality of the findings. Multiple centers of ossification are not uncommon. They usually fuse to form a single sesamoid.

Ten roentgenograms; 4 drawings; 10 tables.

HARRISON SHAPIRO, M.D.
Mt. Sinai Hospital of Cleveland

A Case of Bilateral Os Triangulare Carpi. G. Riva. Radiol. clin. **18:** 78–82, March 1949. (In German)

An accessory center of ossification of the styloid process of the ulna is called *os triangulare*. It is said to be present in 0.1 to 0.6 per cent of the population.

There is still some controversy as to its occurrence, and some clinicians believe that it is actually the remnant of a small chip fracture. The author has seen several cases of a unilateral os triangulare and describes a case of its bilateral occurrence.

Two roentgenograms. H. W. HEFKE, M.D.
Milwaukee, Wis.

GYNECOLOGY AND OBSTETRICS

Measuring the Obstetric Value of the Pelvis (Use of the "Graph Method" for the Interpretation of Radiological Findings). J. Chassar Moir. J. Obst. & Gynaec. Brit. Emp. **56:** 189–204, April 1949.

To appreciate fully the content of this paper, it is necessary to be familiar with the author's previous publications (J. Obst. & Gynaec. Brit. Emp. **53:** 487, 1946; **54:** 20, 1947. Abst. in Radiology **49:** 650, 1947), in which he described a method making use of specially constructed graphs for evaluating pelvicephalic relationship as demonstrated roentgenologically.

Two statements are made which every reader must interpret for himself; first, that with the method described "judgment of the obstetric radiographs is placed on a firmer basis than is possible by use of 'impressionistic' methods of interpretation"; second, that the graphs are "not based on any mathematical formula, but have been worked out as the result of experience gained in a long series of observed cases." This latter statement would seem to the abstractor at least to imply some use of "sizing-up" or "impressionistic" methods.

The radiographic technic originally described has been modified slightly. Instead of a centimeter notched scale, a scale is now used which can be registered on the film itself. A simplified measuring device for determination of the height of the pubic symphysis has also been developed.

The measurements required for the "graph method" of assessing pelvicephalic relationship are given as follows:

1. *For the brim graph:*
   (*a*) The anteroposterior diameter (obstetric conjugate): the distance from the upper, inner margin of the symphysis pubis to the nearest point of the sacrum.
   (*b*) The available transverse diameter of the brim: the transverse diameter that intersects the anteroposterior diameter at its mid point. This is distinct from the widest transverse diameter.
2. *For the cavity graph:*
   (*a*) The lower anteroposterior diameter: the distance between the tip of the sacrum and the nearest point on the symphysis pubis.
   (*b*) The transverse diameter: the distance between the ischial spines.
3. *For the outlet graph:*
   (*a*) Anteroposterior measurement: the distance seen in the lateral pelvigraph between the tip of the sacrum and the mid point between the lowest parts of the curves of the two ischial tuberosities.
   (*b*) The transverse measurement: This is not a linear but an angular measurement of the subpubic arch and is obtained from the pubic arch pelvigraph.
4. *For the head measurement:*
   The lateral pelvigraph is used for cephalometry, and the biparietal diameter lends itself best to radiographic measurement.

To obtain the *available transverse diameter of the brim*, the first step is to determine the object-film distance. In the lateral film a line is drawn from the symphysis to the coccyx, which represents the "line of fire" at which the pelvigraph is made. The mid point of the pelvic brim is then identified on the lateral projection and from this a perpendicular is dropped to intersect the line previously drawn. The distance between the point of intersection and the anterior extremity of the brim conjugate is now measured. By subtracting from it the known object-film distance of the anterior extremity of the brim conjugate, the object-film distance of the available transverse diameter is obtained.

The position of the available transverse diameter in the anteroposterior pelvigraph must now be determined. A simple method for doing this was described in the earlier papers. For greater accuracy, the length of the perpendicular previously drawn in the lateral view is measured on the centimeter scale incorporated in the pelvigraph. On the anteroposterior pelvigraph the calipers are applied to the scale appropriate to the object-film distance of the anterior extremity of the brim conjugate and opened out to span the centimeter reading obtained in the preceding step. One leg of the adjusted calipers is then applied to the posterior margin of the symphysis pubis and the other leg is made to mark a point directly posterior to this. This point indicates the position of the available transverse diameter, which can now be pencilled from side to side of the pelvic brim. The available transverse diameter, having been identified, is spanned with calipers and its measurement read off on the scale appropriate to its object-film distance previously ascertained.

The *transverse diameter (bispinous) of the cavity* is measured by means similar to those enumerated above. When its object-to-film distance has been calculated (usually it is 9–10 cm. below the anterior extremity of the brim of the conjugate), its measurement can easily be read off on the appropriate scale.

The author believes that the "graph method" certainly can give more information as to pelvicephalic relationship than purely physical methods of examination and palpation, and that it can summarize and assess the main features of the obstetric radiograph.

A forecast of dystocia is decidedly more certain when based upon disproportion in the brim graph than when based on disproportion in the cavity or outlet graph only, since the brim is incapable of expansion, whereas the lower pelvis can expand.

As an indication for cesarean section, all that is claimed for the graphs is that they indicate the level at which mechanical difficulty may be expected, but, as the author previously pointed out, the obstetrician feels on more certain ground if he knows that the actual radiographic measurements of the pelvis are sufficient to allow passage of the head.

The further point is made that radiography during the course of labor is of particular value for the intelligent conduct of "trial labor."

Six examples of the use of the graphs are presented.

One roentgenogram; 5 drawings; 18 graphs.

S. F. THOMAS, M.D.
Palo Alto, Calif.

Influence of the Uterus on the Ureter During Pregnancy. W. Rabinowitsch. Urol. & Cutan. Rev. **53:** 81–83, February 1949.

Dilatation of the right renal pelvis and ureter during pregnancy has been reported by many observers. Some attribute it to mechanical pressure; others to hormonal influences (corpus luteum).

The author reports observations which he believes confirm the pressure theory. Roentgenograms of a 20-year-old patient in the sixth month of pregnancy indicated that right-sided pressure of the uterus caused a 90° declination kink of the ureter with consequent retention of urine in the renal pelvis, hydronephrosis, and hydroureter, with pain resembling that of nephrolithiasis. When the patient lay on the left side, the kink was reduced and the pain ceased. One year later the ureter appeared normal, though a slight degree of hydronephrosis persisted.

Three roentgenograms.

MAURICE D. SACHS, M.D.
Cleveland, Ohio

Roentgenography of Vaginal Cysts. F. Szellö. J. Obst. & Gynaec. Brit. Emp. **56:** 228, April 1949.

Routine methods of examination usually suffice to establish the presence of a vaginal cyst and to exclude such conditions as rectocystocele, lateral hematocolpos, perivaginal hematomas and abscesses, pelvic tumors, etc. When the diagnosis remains in doubt, the author believes that radiographic methods may prove useful. He reports 3 cases in which the correct diagnosis was thus obtained. In 2 an opaque medium was employed. In the third the air content of the cyst was sufficient for its delineation.

Six roentgenograms; 4 photographs.

S. F. THOMAS, M. D.
Palo Alto, Calif.

THE GENITO-URINARY SYSTEM

Significance of Symptoms and Roentgen Studies in Urinary Tract Disease. D. Alan Sampson. Pennsylvania M. J. **52:** 715–718, April 1949.

This article consists of eighteen case reports emphasizing the importance of early diagnosis in disease of the genito-urinary tract. Hematuria, pyuria, and the passage of calculi should never be ignored. Roentgen examination by flat plate is entirely inadequate, and excretory urography, retrograde pyelography, or both may be necessary to make a diagnosis.

Eight roentgenograms.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Radiological Signs of Polycystic Disease of the Kidneys. Richard Hickel and Paul Cornet. J. de radiol. et d'électrol. **30:** 113–124, 1949. (In French)

Three possible forms of polycystic renal disease are postulated: (1) those clinically and radiologically easy to establish (large, palpable kidneys, bilateral pyelographic deformities, etc.); (2) those clinically obscure, but which present radiologically at least a unilateral deformity that may be interpreted properly by the trained radiologist; (3) rare cases which are impossible to diagnose clinically or radiologically, and may be seen at operation or postmortem (partial polycystic kidney, containing a small number of cysts).

Polycystic disease is more frequent than many suspect. Bell found one case per 500 necropsies on subjects dying of diverse conditions. Renal lithiasis, pyelonephritis, renal tuberculosis, or malignant tumors may coexist with polycystic disease. Plain films, intravenous and retrograde urography, and pneumorenograms may aid in the radiological diagnosis.

A composite diagram of radiological signs is presented. Signs are divided into major signs, signs of value, and accessory signs.

Major signs include:

1. Augmentation of the surface, and particularly of the height or length of the kidney, and augmentation of the length of the "pelvic arbor"; 90% of cases.
2. Marked disorientation of the axis of the calyces; 80% of cases.
3. Dilatation of quite variable aspect of minor calyces; 68% of cases.
4. Elongation of minor calyces and sometimes of major calyces; 65% of cases.
5. Enlarged aspect resembling a "gouged" area at the base of the minor calyces and at times of the borders of minor calyces; 57% of cases.

Signs of value include:

6. Narrowing of small calyces; 39% of cases.
7. Images of tonality (strands or gray, dull images); 37% of cases.
8. Images of *emboîtement* of Surraco (exemplified by a figure suggesting successive wedges or cones in the calyceal shadow); 36% of cases.
9. Downward extension of renal shadow; 34% of cases.
10. A particular disorientation *en rosette* of a group of minor calcyes (Surraco); 28% of cases.
11. Pronounced incurving toward the spinal shadow of a group of superior minor calyces, bilaterally, and more rarely, of a group of inferior minor calyces.

Accessory signs include:

12. Abnormal orientation of the renal pelvic axis; 17% of cases.
13. Cone-shaped deformation of a major calyx; 15% of cases.
14. Compression amputation of a calyx or group of calyces; 5.7% of cases.
15. Confetti images; 5% of cases.
16. Displacement of the "pelvic arbor" toward the median line; 3.5% of cases.
17. Displacement of the "pelvic arbor" toward the right or toward the left; 2.5% of cases.

In about 55 per cent of cases the deformities are bilaterally symmetrical; in the others they are bilateral and not symmetrical or are unilateral.

Twenty roentgenograms; 1 drawing.

CHARLES NICE, M.D.
University of Minnesota

Regression of Diverticula Following Relief of Vesical Neck Obstruction. Clarence Schneiderman. Canad. M. A. J. **60:** 396–399, April 1949.

The author undertook a cystographic study of the regression in diverticula following the surgical relief of obstructive lesions at or distal to the bladder outlet.

He presents 5 selected cases as a clinical demonstration of the potential restorative capacity of the bladder, despite prolonged weakening and distortion from back-pressure effect and increasing demand on the bladder musculature. In all of these, except one, there were complete regression and disappearance of all roentgen evidence of diverticula within periods of four to eight months following relief of the obstruction.

The conclusions reached are that obstruction is an important etiological factor in formation of bladder diverticula, that infection may fix the sac by peri-diverticular adhesions so that regression cannot occur, and that the solitary retention type of diverticulum does not regress as do the multiple small diverticula.

Six roentgenograms; 1 drawing; 1 table.

HARVEY J. THOMPSON, JR., M.D.
Jefferson Medical College

Primary Carcinoma of the Male Urethra. José Miguel Gómez and Mauricio Firstater. Prensa méd. argent. **36:** 319–328, Feb. 18, 1949. (In Spanish)

The authors publish the third case in the Argentine medical literature of malignant tumor of the male urethra diagnosed in an early stage and given successful surgical treatment. Attention is called to the long evolution of the process, something more than a year from the occurrence of burning on urination and eight months after appearance of a small tumor. The age of the patient was thirty-five years. Urethrography with 15 per cent sodium iodide furnished valuable information in this case.

JAMES T. CASE, M.D.
Chicago, Ill.

THE SPINAL CORD

Differential Diagnosis of Spinal Cord Lesions. J. Lawrence Pool. S. Clin. North America **29:** 521–537, April 1949.

From the neurosurgical standpoint, diseases of the spinal canal may be broadly classified as neoplastic, inflammatory, traumatic, congenital and "miscellaneous." A careful history of systemic and neurological symptoms, stressing the date of onset and details of the march of symptoms, should go a long way toward determining the general nature of the disease process. The physical and neurological examinations, together with appropriate laboratory studies, usually serve to clinch the diagnosis. Infrequently diagnosis is impossible without exploratory laminectomy.

Roentgenograms are essential to determine the presence of bone erosion and to detect widening of interpedicular spaces in the presence of cord tumors or cysts. Rarely calcification can be seen in cord tumors. In addition, congenital defects in the spine can be diagnosed roentgenologically; primary and metastatic vertebral tumors can be detected and frequently identified; fractures, dislocations, and narrowed intervertebral spaces likewise can be visualized.

Myelography is best carried out with 6 c.c. rather than 3 c.c. of pantopaque because the larger amount gives better visualization and is almost as easily removed. A stringy, beaded appearance suggests arachnoid adhesions or varicosities. A unilateral defect in the dye column close to an intervertebral space may indicate a herniated disk or neurofibroma. A ventrally placed disk or tumor may completely block the passage of the medium. An extradural mass may produce a smooth compression defect along a lateral margin of the opaque column.

The author discusses in considerable detail pertinent differential points in the history, physical examination, and neurological examination of patients having spinal cord lesions. He also takes up the laboratory diagnosis, emphasizing the cerebrospinal fluid findings. Current concepts regarding the use of electromyography and myeloscopy in the diagnosis of cord lesions are discussed briefly.

J. R. HANNAN, M.D.
Cleveland Clinic Foundation

RADIOTHERAPY

The Treatment of Cancer: A Radiological Analysis of Prof. J. van Roojen's Report on the Treatment of an Experimental Clinical Series. M. Weinbren. South African M. J. **23:** 224–233, March 26, 1949.

In a paper on the x-ray treatment of epithelioma in a special supplement to the *Proceedings* of the Cape Town Post-Graduate Medical Association, published in December 1947, van Roojen advocated irradiation at intervals of twelve hours instead of the usual twenty-four, with an over-all treatment period of one hundred and twenty hours (eleven exposures in five days) and a total dose of 2,400 r instead of 4,000 to 10,000 r as commonly used.

In the present analysis of van Roojen's report the author proceeds to show that no theoretical or experimental evidence was produced to justify the claim that if treatment were given according to that plan better results would be obtained than with treatment every twenty-four hours, with larger doses. He criticizes Professor van Roojen for over-stressing the results in skin cancers, which are known to respond readily to a wide variety of technics, while paying inadequate attention to the "really serious cases of cancer," such as carcinoma of the cervix, esophagus, pharynx, and larynx. The claim of an over-all 50 per cent cure rate is said to be quite untenable, as it applies only to skin cancers, in which better results can be obtained by standard methods. Advocacy of the same dose for all cancers, regardless of their varying radiosensitivity, is "quite inexplicable." The doses recommended are wholly inadequate, but for some conditions the delivery of too much radiation in too short a time carries serious risk of radiation injury.

Symposium on Small Field Therapy for Deep-Seated Tumors. P. R. Steed, A. D. O'Connor, L. F. Lamerton, J. G. Winternitz, W. V. Mayneord, and D. W. Smithers. Brit. J. Radiol. **22:** 185–209, April 1949.

Future advances in radiation therapy will undoubtedly depend on the solution of many biological problems, but unless the physico-geometrical problem of accurately delivering the desired radiation to the space occupied by the tumor without too much damage to the normal tissues is solved, many of the benefits of biological research will be neutralized.

The geometrical and mechanical problems of accu-

rate beam direction are exhaustively discussed by Mayneord. These problems are especially acute when many small beams are used. With multiple small beams, the volume of maximum dosage is not at the region of intersection of the axes, but at some point above this, so that the beams must be directed to intersect below the lesion. A graph is presented giving the displacement for one field size.

Winternitz describes a device which enables easy and accurate direction of the beam to any depth.

Rotation technics are briefly, and incompletely, discussed by Smithers and Steed. It is pointed out that such technics represent an extension of multiple-small-field irradiation. Isodose curves for three rotation situations and three similar situations for multiple ports are given.

The practical application of one multiple-small-field technic is described in detail by Winternitz and Smithers. First the tumor size and location are determined as accurately as possible. Sixteen small ports are then arranged, eight anterior and eight posterior, angulated to locate the points of maximum dosage at the tumor-bearing area. By this method 5,000 to 6,000 r may be given to the tumor if not over 7 to 8 cm. in diameter, with the production of only a mild erythema where the surface fields overlap.

Lamerton and Steed present isodose curves for fields inclined at various angles to the surface of the scattering medium and a geometrical method for summation of the single field isodose curves in practice. A radiographic method of checking angulation and centering is described by O'Connor.

In the concluding paper of the symposium, Smithers summarizes the results of a clinical trial of the multiple-small-field technic in a group of cases of carcinoma of the bronchus, but none of the patients appear to have been followed as long as five years. One patient, in whom the diagnosis was confirmed microscopically, was free from symptoms after four and a half years.

Fifty-three illustrations, including 6 roentgenograms; 1 table.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

A Technic for Contact Radiotherapy in Laryngeal Cancer. Jean Terracol and Paul Lamarque. J. de radiol. et d'électrol. **30:** 140–142, 1949. (In French)

A technic of treating cancer of the larynx by contact radiotherapy after laryngofissure is presented. A week after laryngofissure contact therapy is given to small fields in four bi-weekly treatments, for a dose of 4,000 r. The method has been used in seven patients who refused laryngectomy or who had inoperable lesions. Within three weeks of the time of surgical laryngofissure cicatrization of the lesion is observed.

CHARLES NICE, M.D.
University of Minnesota

Carcinoma of the Rectum and Anal Canal. Treatment with Very High Voltage X-Ray Therapy. I. G. Williams. Brit. J. Surg. **36:** 376–381, April 1949.

The use of radium and x-rays in the range of 200–250 kv. has been uniformly disappointing in the treatment of carcinoma of the rectum. Since 1937, 192 cases (140 primary and 52 recurrent after surgery) have been treated by x-rays generated at 1,000,000 volts. Ninety-four per cent had inoperable disease. Supervoltage therapy produced complete resolution of the primary growth with relief of symptoms due to the tumor in 42 per cent of the cases. Twenty-four patients were alive for varying periods at the time of the report. Five of those with primary disease and 3 with a recurrent lesion had survived five years or longer. Of the dead 6 lived five years. Also, in carcinoma of the anus, supervoltage therapy gives better results than ordinary deep therapy.

No specific plan for treatment is given, but general remarks concerning x-ray reactions, method of tumor localization, and hazards in the use of high-voltage therapy are mentioned.

The author concludes that in carcinoma of the rectum, surgery remains the treatment of choice if possible.

Five tables.

M. M. MANALAN, M.D.
Indiana University

Carcinoma of the Vulva. Report of 313 Cases. James P. Palmer, Marvin G. Sadugor, and Melvin C. Reinhard. Surg., Gynec., & Obst. **88:** 435–440, April 1949.

The authors report from the Roswell Park Memorial Institute, Buffalo, N. Y., their series of 313 cases of carcinoma of the vulva occurring in a group of approximately 8,000 gynecological malignant tumors, representing an incidence of 3.88 per cent of all cancers of the female genitalia.

The average age at admission for the 313 patients was 61.5 years. Eighty per cent of the patients had passed the menopause, which indicates that the carcinomas of the vulva constitute a predominantly postmenopausal or so-called degenerative disease. The ratio of married to single patients was about 10 to 1. There were no women of Negro or Jewish extraction in the entire series.

The primary complaint occurring in 160 patients was itching and pruritus. The next commonest, occuring in 122 patients, was swelling or perception of the lesion by the patient herself. Leukoplakia was present in only 12 per cent of the cases. Only 4 patients were diabetic and only 3 had positive Wassermann reactions. The duration of symptoms before admission to the Institute varied from one month to several years.

The histologic forms or types present in this series were as follows: epidermoid carcinoma 300; malignant melanoma 7; adenocarcinoma of Bartholin's gland 1; myosarcoma 1; basal-cell carcinoma 4.

The authors tabulated the results of treatment according to periods of years and according to the type of therapy used, that is, coagulation or surgery, radiation alone, and combined surgery and radiation. Also they classified the cases according to the extent of disease and according to treatment prior to admission to their institution. They conclude that there is a marked increase in cure rate in recent years, which may be attributed to the more radical surgical procedures and to the increased radiation dosage used subsequent to 1928.

Prior to 1929 very few patients had more than local excision or local coagulation of the lesion. Subsequent to 1929 an increasing percentage of the patients had total simple vulvectomy with treatment of metastatic nodes by irradiation. Since 1941 more radical surgery is being used, consisting of total vulvectomy and superficial groin dissection, unilateral or bilateral, when there are definite inguinal nodes which are thought to be metastatic. When there are no definite nodes or when there are soft, tender nodes which are thought to be

inflammatory, groin dissections are omitted. These patients are followed closely and if the soft tender nodes regress, no groin surgery is performed. The authors have not used the so-called Taussig or Basset type of radical groin dissection in any case of carcinoma of the vulva and note that Smith and Pollack conclude that best results in their series of 146 cases were obtained when a vulvectomy with bilateral superficial groin dissection without removal of the iliac or deep inguinal nodes was performed.

In the inoperable cases, whether inoperable because of the disease or because of the patient's poor general condition, and in postoperative recurrent cases, whether the recurrence be local or in the nodes, x-ray therapy is used and often gives prolonged relief and occasionally apparent cure.

In evaluating the end-results, the authors present the methods of classification of cases used by Taussig, by Bervin, by Smith and Pollack, at Memorial Hospital, and by themselves. The comparative end-results reported from these sources are as follows:

	Taussig	Bervin	Memorial Hospital	Authors' Series
Total number cases	108	244	146	170*
Number free of disease 5 years	32	65	38	45
Survival rate (5 years free of disease)	29%	26.6%	26.2%	26.5%

* 1929 to 1941 inclusive

It is noted from the four methods of classification outlined that in two of the clinics, great emphasis is placed on the extent of the primary neoplasm, while in the other two clinics no consideration is given to the extent or size of the primary lesions. Also, in none of the four clinics is the site of origin of the disease considered in arriving at a clinical classification, although some of the clinics show very definitely that the site of the primary involvement does influence the prognosis.

The authors propose that a committee should be appointed from some National Gynecological or Cancer Society to formulate an adequate classification.

Five tables.

MARLYN W. MILLER, M.D.
University of Pennsylvania

Radium Therapy for Carcinoma of Bartholin's Glands. Harry H. Bowing, Robert E. Fricke, and Thomas J. Kennedy. Am. J. Roentgenol. **61:** 517–529, April 1949.

Primary carcinoma of Bartholin's glands is a very rare disease, only 50 to 90 cases having been reported. It is more frequently adenocarcinoma than of the squamous-cell type. Differentiation must be made from other vulvar carcinomas, primary tuberculosis of Bartholin's glands, sarcoma, syphilis, and other infections.

The prognosis is poor since early diagnosis is quite rare. Boughton (Am. J. Surg. **59:** 585, 1943) is said to regard the lesion as curable if surgical excision is done before the capsule has been invaded. The authors feel that, in the case of localized lesions of low malignancy, wide excision and subsequent prophylactic radium should prevent recurrence. Clinically extensive carcinoma of a Bartholin's gland, localized to the primary field, if treated with radium designed for cure, may not recur.

Special study of the lymphatic drainage of Bartholin's glands has never been undertaken, but most authors feel that it is identical with the lymph drainage of the vulva and that metastasis takes place by this route. One case from the literature is cited suggesting metastasis via the blood stream (Rabson and Meeker: Surg., Gynec. & Obst. **67:** 505, 1938).

The authors present seven cases in considerable detail. The patients ranged between thirty and sixty-nine years of age, duration of symptoms between a few months and four years. All patients received radium therapy, but some had had previous attempts at resection. Roentgen therapy was given for palliation and to distant metastases. Four of the patients survived more than five years.

HARRISON SHAPIRO, M.D.
Mt. Sinai Hospital of Cleveland

A Simple Method of Applying Vaginal Radium. I. C. Skinner. Texas State J. Med. **45:** 209, April 1949.

For the vaginal application of radium in carcinoma of the cervix, the author suggests the use of a Gellhorn type of pessary drilled to accommodate radium containers. He believes that this circumvents many of the disadvantages of the colpostat which must be held in place with vaginal packing.

One illustration.

Angiosarcoma of the Sternum. Alois Pollak. Am. J. Surg. **77:** 522–527, April 1949.

A case of angiosarcoma of the sternum is presented in which irradiation (8,000 r x-ray therapy plus 900 mg. hr. radium) was followed by a definite regression of the tumor. About eight months later a radical excision of the manubrium and upper part of the sternum was done, from which the patient made a rapid recovery without impairment of function. In spite of the radiosensitivity of the tumor, the complete excision of the mass and surrounding tissues, and the apparent complete recovery of the patient after surgery, metastases occurred to the skull and left humerus a year after the irradiation. Death ensued within eighteen months from the onset of the symptoms. No local recurrence, however, had developed.

Nine illustrations, including 5 roentgenograms.

Roentgen Ray Treatment of the Eye. Further Experiences. Herbert S. Alden, Jack W. Jones, and Joseph Rankin. Arch. Dermat. & Syph. **59:** 430–434, April 1949.

For the past fifteen years the authors have been using roentgen rays for the treatment of diseases of the eye. They have obtained their best results in infected corneal ulcers due to exogenous causes, *i.e.*, trauma or foreign bodies, and for all practical purposes for the past few years they have limited roentgen therapy to lesions of this type.

The roentgen radiation was obtained by means of mechanical rectification and a water-cooled Machlett tube. The factors were 120 kv., 6 ma., with a tube-target distance of 8 inches, without filtration, 160 r per minute. The eyelids were held open by an assistant, the patient looking directly at the filament light of the tube, and the surrounding area was shielded well with lead foil. For the past eight years, a one-half inch brass tube

has been used as an application medium, without lead shields, with satisfactory results. Most patients received 70 to 80 r (one-quarter erythema dose) at weekly intervals; a few persons, with acute painful corneal ulcers, received 120 r as the initial dose and 80 r for subsequent doses. The average number of treatments was five.

Repeated slit-lamp examinations of eyes treated with roentgen radiation in proper doses has not revealed a single case of cataract due directly to such treatment.

Treatment of Retinal Glioma. E. M. Japha. Brit. J. Cancer **3:** 16–26, March 1949.

After a review of the literature on the treatment of retinal glioma, data on 19 cases seen at the Middlesex Hospital, England, between 1929 and 1946 are presented. Four of the cases were recurrent after an attempt at cure elsewhere, and 8 patients were referred for radiotherapy after enucleation elsewhere. Thirteen of the patients were males. Age at the time of treatment varied from seven months to five years. In a high proportion of cases there was a considerable delay in starting treatment. In all but 1 of the 8 unilateral cases the right eye was affected, whereas in 9 of the 11 bilateral cases the condition was more advanced in the left eye, and this was the eye excised, the other to be treated by radiotherapy.

Primary Cases: In 3 of the 7 cases of primary unilateral disease, surgery alone was employed; in 1 of these there was optic nerve involvement. In 3 other cases surgery was followed by irradiation, in 2 of which there was evidence of extrabulbar spread. One case was treated by irradiation alone. In the 8 *bilateral cases*, the eye in which the disease was more advanced was excised. The other eye was treated by external radiation in 7 of these. The remaining case was referred after removal of one eye for radiotherapy to the second, but disease in this eye had progressed so far that the sight could not be saved and it also was enucleated. The child is alive without sign of recurrence five years later.

Recurrent Cases: All 4 recurrent cases were treated by radiotherapy. One case was seen with a recurrence in the socket five months after removal of the only affected eye. The other 3 cases had recurrences in the remaining eye following treatment, respectively, by insertion of radon seeds into the eye, the insertion of radium needles into the orbit, and diathermy puncture of the growth, the first eye having been excised.

Since 1941 all cases of retinal glioma have received deep x-ray therapy. In an endeavor to treat as small a part of the eye as possible, the author has used circular fields of 2 and 3 cm. diameter by means of special tubular applicators. These are used in connection with deep x-ray tubes, treatment being carried out at 190 to 220 kv. and focus-skin distances of 30 to 35 cm. A Thoraeus filter, giving a half-value layer of 2.1 mm. Cu, was used until 1942; since then, except in 1 case, filtration has been 0.5 or 0.8 mm. Cu, giving a half-value layer of 1.3 or 1.4 mm. Cu. Multiple fields are used, *e.g.*, lateral (temporal), medial (transnasal), superior and inferior orbital.

Daily treatments are given, the daily dose varying from 100 to 300 r to one or two fields, the course lasting from three to six weeks. The total tumor dose has varied, depending partly on the progress observed ophthalmologically. A minimum tumor dose of 3,300 r is considered essential, but overdosage, which may lie at anything more than 4,500 r, is warned against. Still more varied has been the total skin dose applied to individual fields. The highest was 4,750 r in fifty-seven days. This maximum dose was 50 per cent higher than the 3,100 r and 3,200 r given to two fields in another case. All other applied skin doses were below 2,700 r, and most were between 1,000 and 2,000 r.

In 3 cases, in 2 of which there was optic nerve involvement, postoperative irradiation was given after enucleation of the eye. A radium mold was used in 2 cases and deep x-ray therapy in the other.

Surgical excision is the mainstay of therapeutic procedure in retinal glioma. In all bilateral cases in this series, at least one eye was excised. The 3 patients with primary unilateral growths treated by surgery alone are still alive and well three and three-quarter, five and three-quarter, and six years later.

Two cases treated by radium molds and 2 of 3 cases treated by deep x-ray irradiation more than five years ago are alive and well fifteen, ten, five, and five years after treatment. Cataract developed in 3 of these patients, and 2 have had operations for its removal. The sight in these 3 cases is partial only; in the fourth case it is normal.

Of the 15 patients in the series treated by radiotherapy, 11 were alive and well at the time of the report.

Two roentgenograms; 7 tables.

Thyrotrophic Exophthalmos. C. J. B. Muller. South African M. J. **23:** 221–222, March 26, 1949.

A case of severe exophthalmos in a 28-year-old woman, a South African native, was treated by roentgen irradiation of the pituitary, with excellent results. The irradiation was given through two lateral fields, 7 × 7 cm., each field receiving 100 r daily for eighteen applications, giving a dose to the pituitary of 1,850 r (skin dose 2,150 r) over a period of twenty-four days (250 kv., 1.5 mm. Cu and 1.0 mm. Al filtration, 50 cm. focal skin distance).

Six photographs.

Lymphatic Radiotherapy in Infancy. D. Cirillo. Il Lattante, June 1948 (Abst. in Prensa méd. argent. **35:** 2481–2482, Dec. 24, 1948). (In Spanish)

The author has studied 206 children who received radiotherapy for affections of the lymphatic ring of Waldeyer, without subsequent complications or interference with any later surgical exploration where this seemed necessary.

The best results were obtained in simple recurrent tonsillitis and the worst results in tonsillar hypertrophy with recurring tonsillitis. The author tries to differentiate between those cases in which the lymphatic tonsillar tissues were enlarged (radiosensitive form) and the radioresistant group, in which the increase in size was due to interstitial connective tissue. The age is of importance; the younger the patient, the more effective the treatment. The optimum age was four years.

The technic involved the application of 500 to 1,000 r, divided into 6 sessions given at six-day intervals. Usually there were four treatments at 120–140 kv., using 3.0 mm. Al filter, and two final sessions at 160–180 kv., with a filter of 0.5 mm. Cu plus 3.0 mm. Al. The focus-skin distance was usually 30 cm. and the irradiated field varied from 5 × 5 to 5 × 7 cm.

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Treatment of Secondary Amenorrhoea with Low Dosage Irradiation of Ovaries and Pituitary Gland. P. Lyon Playfair and Alan Booth. J. Obst. & Gynaec. Brit. Emp. **56:** 260–268, April 1949.

This paper is a report on a selected series of 21 cases of secondary amenorrhea (cessation of menstruation for four months or more) treated by low-dosage irradiation of the ovaries and pituitary.

The authors discuss, first, the safety of pituitary irradiation, pointing out that in the treatment of pituitary adenomata massive doses have produced no demonstrable cytological change, and citing from the literature series of cases in which irradiation in low dosage produced no permanent change in the menstrual cycle. The difference between a harmful and a safe dose is, however, probably slight, and anything other than small variations in dosage are therefore to be avoided. [No mention is made of possible genetic effects, which certainly are to be considered even though the dosage is small.]

The irradiation factors were 200 kv., 15 ma., 1.5 mm. copper and 1.0 mm. aluminum filtration, and 50 cm. skin distance. For the ovaries, fields measuring 15 × 15 cm. to the right and left of the pelvis, anteriorly and posteriorly, were used. The pituitary was treated with the same quality x-rays using a 6 × 6-cm. field over the forehead and directing the radiation to the sella turcica. Doses were measured on the skin, with backscatter. The dosage schedule was as follows: First day right and left anterior pelvic fields 75 r each, pituitary field 75 r. Seventh day right and left posterior pelvic fields 75 r each. Fourteenth day right and left anterior pelvic fields 75 r each, pituitary field 75 r.

Success was measured by return of menstruation within six weeks. In 14 of the series of 21 cases, or 66.6 per cent, a normal periodicity was established; in 2, or 9.5 per cent, the periodicity was improved, and in 5, or 23.9 per cent, the treatment was considered to have failed.

Details of the 21 cases are tabulated, as are the results reported by others.

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Chronic Leukemia of Long Duration: With a Report of 31 Cases with Duration of Over Five Years. Herbert C. Moffitt, Jr., and John H. Lawrence. Ann. Int. Med. **30:** 778–790, April 1949.

From a total of approximately 190 cases of chronic myelogenous and chronic lymphatic leukemia seen and treated at the Crocker Laboratory, University of California, since 1937, 31 cases of particularly long duration were selected for presentation. All these patients had lived five years or more after the diagnosis was established by blood counts. Tables evaluating sex, age duration of illness, onset of symptoms, blood count, and type of leukemia are presented.

Splenomegaly was marked at the onset of three of the myelogenous cases and lymphadenopathy of considerable degree was present from the beginning in four of the lymphatic cases. These findings are ordinarily thought to connote a poor prognosis. The treatment in most of these cases has been so varied that an analysis of its effect on duration would not be of value.

The authors' treatment has been chiefly with radioactive phosphorus occasionally supplemented with roentgen therapy. A few of these patients had been treated previously with roentgen irradiation or Fowler's solution. The total dose of P^{32} has depended more upon how long the patient was under immediate supervision than on the severity of the leukemia. Eight patients alive after five years were treated by radiophosphorus only. Many patients developed anemia terminally, as one would expect, but a number were alive with very satisfactory blood counts many years after the diagnosis was first made. Four patients exhibited prolonged remissions following treatment. Infection, sometimes held to be a cause of remission, apparently played no part in the long duration of these cases. Repeated blood examinations have shown no constant changes of significance during the course of intercurrent infections.

The literature of chronic leukemia of long duration is reviewed.

Four tables.

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RADIOISOTOPES

Use of Tracer Doses of Radioactive Iodine, I^{131}, in the Study of Normal and Disordered Thyroid Function in Man. Sidney C. Werner, Edith H. Quimby, and Charlotte Schmidt. J. Clin. Endocrinol. **9:** 342–354, April 1949.

This report presents the results of a fact-finding survey of the uptake by the thyroid of tracer doses of radioactive iodine of mass 131 (eight-day half-life) during normal and disordered thyroid gland function in man.

Tracer doses of I^{131} without significant amounts of stable iodine (carrier) were given by mouth in the nonfasting state. Doses of between 40 and 100 microcuries were used, the smaller amount being given routinely in the later studies. Radioactivity in the thyroid gland was measured with a Geiger counter placed at a standard distance of 15 cm. from the neck, with the thyroid isthmus as a center, and with the head and neck in a special holder. A wide counter aperture was designed which permits the accurate measurement of radiation from an area of the neck measuring 15 × 10 cm., sufficient for all except extremely large goiters. Measurements of uptake were made at the end of a twenty-four-hour period. All patients were studied after complete medical work-up or after operation.

In a control series numbering 57, a range of uptake of between 10 and 35 per cent of the tracer dose at twenty-four hours was found to include all but 9 per cent of the subjects. Most of the low values, between 10 and 15 per cent, and a single value below 10 per cent, were found in women over forty years of age.

The high uptake limit in the control group (35 or 40 per cent) permits an appreciable percentage of cases of proved toxic goiter to be included in the normal range. This same overlap is found when the "accumulation gradient" is determined and occurs with plasma precipitable iodine and basal metabolic rate determinations.

In cases of toxic goiter, the general correlation which exists between iodine uptake by the thyroid gland and hormone secretion as reflected by the basal metabolic rate can be disrupted by the treatment of the thyrotoxicosis.

Lack of correlation between iodine uptake and basal

metabolism may be found in active thyroiditis, malignant exophthalmos, Simmonds' disease, Addison's disease, and anorexia nervosa.

The depression of iodine uptake by previously administered thyroid substance or stable iodine may persist for weeks.

The authors conclude that the radioactive iodine tracer test, when used as a clinical tool for determination of thyroid function, has diagnostic usefulness only when the results are properly interpreted in conjunction with other clinical and laboratory aids. It does not replace sound clinical judgment.

Eight tables.

Use of Radioactive Iodine in the Treatment of Graves' Disease. Myron Prinzmetal, Clarence M. Agress, H. C. Bergman, and Benjamin Simkin. California Med. **70:** 235–239, April 1949.

The use of radioactive iodine in the treatment of hyperthyroidism is discussed. To determine the uptake of iodine by the gland the patient is maintained on a low-iodine diet for four to six weeks and is then given a small tracer dose of I^{131}, usually 0.5 to 1.0 mc. Simultaneously the same dose of radioiodine is placed in a 50-c.c. vial and diluted with 50 c.c. water, to serve as a standard of measurement of radioactivity. After forty-eight hours the patient returns and counts are taken over the thyroid gland (neck count) and over the thigh (in order to test the amount of radioactive iodine in non-thyroid tissues). Subtraction of the amount absorbed in non-thyroid tissues from that taken up by the thyroid determines the actual thyroid uptake. The count of the standard as determined at this time is taken as 100 per cent, and on this basis the percentage uptake by the thyroid is calculated, thus eliminating the factor of decay.

Patients with Graves' disease have shown an uptake of radioactive iodine from 35 to 98 per cent, whereas euthyroid individuals show an uptake of 10 to 30 per cent. Of diagnostic significance is the fact that thyroiditis, which may mimic hyperthyroidism, shows, relatively speaking, a very low uptake of radioactive iodine.

Twenty-six patients treated with radioactive iodine for uncomplicated Graves' disease were followed for one year or longer. Twenty-five were clinically well at the time of this report and the remaining one was greatly improved. One patient had a relapse but responded to a second course of treatment. Two patients returned to a euthyroid state but were left with nodular glands, for which surgical removal was advised, but refused. The total dose of I^{131} ranged from 0.5 to 10 mc., the average being 4.4 mc. The average uptake of iodine was 62.4 per cent.

The authors are of the opinion that radioactive iodine is a very effective therapeutic agent for the management of thyrotoxicosis, though they do not recommend its use for nodular goiters. The advantages of the use of radioactive iodine are as follows: (1) There is no mortality. (2) Patients can be treated while ambulatory. (3) The cost is less than that of surgery. (4) There are no complications such as thyroid storms, postoperative pneumonia, etc. (5) There is a lower incidence of progressive exophthalmos. Certain disadvantages also exist: (1) It is difficult to estimate the correct dosage, and is therefore necessary to treat the patient over a long period of time with small doses, and in some instances hypothyroidism ensues. (2) There are still unknown dangers from radioactive iodine. (3) It is impossible to study the histologic structure of the gland. (4) A certain amount of technical skill in administering radioactive iodine is required.

Four illustrations.

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Further Studies of the Circulation with Radioactive Erythrocytes. G. Nylin and S. Hedlund. Am. Heart J. **37:** 543–550, April 1, 1949.

The authors claim that new possibilities of investigating the normal and pathological physiology of the circulation have been opened by the use of tagged red cells.

They report experiments with the injection of tagged red cells and of radioactive plasma, and with double injections of radioactive whole blood. Tagged red cells remained constant in their activity for at least one hour after injection, and then over a twenty-four-hour period gradually lost their activity. Labeled plasma lost its activity very rapidly. The radioactive phosphate from the plasma enters the red cells and reaches its maximum activity in the corpuscles about five hours after the injection, with a gradual loss of activity thereafter. With double injections of whole blood, the second being given approximately thirty minutes after the first, it was found that the activity following the first injection is constant; after the second injection the activity is also practically constant up to the sixty-fourth minute, decreasing slowly during the next twenty-four hours.

The authors have attempted by mathematical means, from estimations of dilution curves of arterial blood, to determine the residual blood in the heart, the cardiac output, and the thoracic pool of blood.

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EFFECTS OF IRRADIATION

Reactions to X-Ray and Radium Therapy in the Treatment of Cancer of the Uterine Cervix. Daniel G. Morton and John A. Kerner. Am. J. Obst. & Gynec. **57:** 625–636, April 1949.

A thorough study of 621 patients with cancer of the cervix is reviewed with particular reference to the immediate and late reactions following radiation therapy.

The use of radium alone produced little significant general reaction but sometimes caused the induction or exacerbation of infection. However, local destruction of tissue, fistula formation, etc., were not common when radium alone was used.

Roentgen therapy often caused a general reaction and sometimes produced so much prostration and metabolic disturbance that death ensued. In this series 19 patients died as a consequence of irradiation and 2 others probably died of the effects. Roentgen therapy also caused connective-tissue changes in the form of proliferation, which in some cases resulted in obstruction or necrotic changes due to endarteritic changes.

The incidence of complications was definitely greater in cases in which both radium and x-rays were used and also increased as the dose increased. The authors believe that where effective x-radiation is added to an

established radium technic, thought should be directed toward reducing the irradiation to the tissues within the effective range of the radium, lest these receive a lethal dose from the combined sources.

Statistics for the 436 patients in this series treated solely by irradiation show that the percentage of survivals increased as the dose of radium and x-rays was increased. However, the increased incidence of late complications in and about the cervix with x-ray and radium therapy combined, particularly in the large doses, suggests that these tissues were sometimes over-irradiated. Factors such as screening, intensity, duration of treatments, and interval between treatments may well play a part in this connection.

Efforts should be continued to determine the radiosensitivity of the tumor, since reduced amounts might frequently be in order. Other measures which deserve further investigation are the use of antibiotics, continuous hospitalization during roentgen therapy, palliative surgery in cases of irradiation necroses without recurrence, and the determination of isodose curves to prevent over-irradiation.

It is apparent that complications cannot be completely eliminated, but searching analysis of present methods and results can lead to some improvement.

Ten tables.

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Aseptic Necrosis of Femoral Head Following Roentgen Therapy for Carcinoma of the Cervix Uteri. Stanley D. Simon. Bull. Hosp. Joint Dis. **10:** 50–58, April 1949.

The literature on aseptic necrosis of the femoral head following roentgen therapy for carcinoma of the cervix is reviewed and a single case is reported. In 1936 a large carcinoma of the cervix [amount of extension not stated] was treated with radium and roentgen irradiation. The external therapy consisted of doses of 750 r (factors 198 kv., 0.5 mm. copper, 30 ma., 70 cm. target-skin distance) to each of six portals (measuring 18 × 14 cm.), repeated after two months. One month after the second course was completed an erythema appeared over the left lateral field. Skin grafting and other measures were used before healing was complete, in fourteen months.

Seven years later, in 1944, pain developed in the left hip, persisting for three years, when an x-ray examination was made (1947). This showed complete absorption of the left femoral head and part of the neck with probably incidental presence of bilateral protrusio acetabuli, worse on the opposite or right side. Externally the skin showed telangiectasia of all treated areas, with atrophy and fibrosis of the left lateral field. The right anterior field also showed fibrosis.

[This complication of irradiation is fortunately rare and this particular case seems unusual. One would certainly not expect anything like the reaction described from such treatment as is outlined. It seems possible, in view of the protrusio acetabuli, that there was pre-existing disease in the hip which contributed to the result. Also it should be pointed out that the case represents an eleven-year cure of carcinoma.]

One roentgenogram; 2 photographs.

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Study of Connective-Tissue Reaction to Radiation. The Sieve or Chess Method. B. Jolles. Brit. J. Cancer **3:** 27–31, March 1949.

In the study of the tissue reactions to ionizing radiations several effects have to be gone into separately: (1) the direct effect of radiation on cells (intracellular effect); (2) the direct effect on the intercellular elements; (3) the effects on cells caused by the stroma (stromal effect); (4) the effects on cells and stroma in the irradiated tissues caused by the neighboring tissues (external effect). Only by special methods and technical arrangements can these effects be studied.

The author describes a new technic for the study of connective-tissue reaction to radiation, consisting in the irradiation of accessible tumors (breast, skin) through a lead sieve with circular or square apertures of diameters 1.0 to 2.0 cm. On the basis of 9 cases studied thus far, the following preliminary conclusions are reached: (1) The "sieve-chess" technic is a workable one for the study of direct and indirect effects of irradiation. (2) The connective-tissue reaction takes place not only in the irradiated areas, but also in the neighborhood protected from the direct irradiation. (3) There are visible effects on cells not directly exposed to the radiation. (4) The pattern of connective-tissue destruction and regeneration can be studied.

As a general inference, it can be said that the irradiation affects the connective-tissue cells and induces a kind of "over-differentiation." This consists chiefly in the deposition of an excessive amount of collagenous fibrils, which are organized into solid, coarse bundles in the exposed parts where the fine connective-tissue network is grossly altered. Lymphatic channels and blood capillaries are greatly affected, compressed, and blocked. This has a considerable effect on tumor nourishment, the lack of which enhances tumor tissue degeneration.

Two photographs; 4 photomicrographs.

Fogging of Photographic Film by Radioactive Contaminants in Cardboard Packaging Materials. J. H. Webb. Physical Rev. **76:** 375–380, Aug. 1, 1949.

Here, at last, is the factual report on the fogging of films attributable to the first atomic bomb. Due to spots of fog from radium dial paint that got into packaging material during paper salvage in World War II, Eastman Kodak Company had selected mills where raw material was carefully controlled. One of these, at Vincennes, on the Wabash River in Indiana, produced on Aug. 6, 1945, a run of strawboard that fogged film. Three weeks after packaging, development showed ten to several hundred dark spots from radiation, sometimes penetrating through several layers. The guilty spots of strawboard proved to contain beta but no alpha activity, showing that they did not represent natural radioactive minerals. Another mill at Tama, Iowa, on the Iowa River, produced similar active strawboard in September 1945. Energy of the betas (0.6 mev) and half-life (about thirty days) were determined roughly and suggest radioactive cerium[141]. Calculation showed the possibility of this having come from the bomb test at Alamogordo on July 16, 1945, supposing that the fission products contained 50 gm. of Ce^{141}, and that this fell out more or less evenly over the United States.

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